Royaume du Maroc المملكة المغربية

Université Sidi Mohamed Ben Abdellah

كلية الطب والصيدلة

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FACULTÉ DE MÉDECINE ET DE PHARMACIE

Year 2020

Thesis N° 157/20

THE ROLE OF ISLAMIC CIVILIZATION IN THE EVOLUTION AND DEVELOPMENT OF MEDICAL THINKING : CLINICAL TRIALS

THESIS

SUPPORTED AND PRESENTED PUBLICLY ON 05 /11/2020

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Born on August 02,1993 in Fez

TO OBTAIN MEDICAL DOCTORATE DEGREE

KEYWORDS:

Clinical Trial - Islamic Civilization - Medical Thinking

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INTRODUCTION

At various times in our lives and to varying levels of intensity, we all use, provide or pay for health and social care. As we decide what to do, take, offer or buy, we need evidence that is reliable, robust and trustworthy about different options.

Contemporary medicine is shaped by the understanding of why treatments need to be tested, rather than being based on assumptions that “it must work” before the treatment has even been tried, or based on impressions after it has been used a few times, by understanding the needs for fair tests comparing alternative treatment options. Genuine uncertainties must be identified and addressed, and research to find the most effective and appropriate treatments need to build on research to identify the most effective and appropriate methods for doing that research. Comparisons need to be fair at the outset, and then kept fair as the treatments being tested are given; outcomes are measured; and results are analyzed, reported, and combined in systematic reviews of all the relevant and trustworthy evidence.

Over the past half century, health care has had a substantial impact on people’s chances of living longer and being free of serious health problems. It has been estimated that health care has been responsible for between a third and a half of the increase in life expectancy and for an average of five additional years free of chronic health problems. Even so, the public could have obtained – and still could obtain – far better value for the very substantial resources it invested in research intended to improve health. Contemporary medicine is very effective facing pathologies that have ravaged humanity for centuries. Furthermore, some of the treatment disasters of the past could have been avoided, and others could be prevented in future.

Misleading claims about the effects of treatments are common; so all of us should understand how to recognize a valid claim about the effects of treatments and how these are made. Without this knowledge, we risk concluding that useless treatments are helpful, or that helpful treatments are useless.

Similar to many other modern scientific concepts, the roots of clinical trial methodology can be traced back many centuries. The evolution of clinical trials has gone through a long and fascinating journey. During the middle ages, physicians and philosophers of the Islamic civilization embraced and absorbed the Greek philosophy and the Persian medical knowledge and developed a scientific method based on both theory and experimentation. This Islamic logic influenced directly the Western civilization and catalyzed the draft of the British empirical philosophy. This philosophical movement led to the basic approach of clinical trials in the 18th century. From that point, efforts were made to refine its design and statistical aspects. However, most of the contemporary sources on history of medicine propagate the idea that the roots of experimental medicine in its modern form, including clinical trials, first started during the European Renaissance in the 16th to the 18th centuries.

Medieval Islamic medicine introduced several aspects of medical research which anticipated modern clinical trial designs. Concepts such as the need for experiments in medical practice, the importance of animal studies before treating patients with a drug and acknowledgment of the differences between the physiologies of animals and humans, treatment comparisons to a control group, and introducing statistics to medical research can be traced back to the scientific insights of this golden period.

This thesis is an attempt to capture the major milestones in the evolution of clinical trials as an evolution of ideas. Shedding the lights on the Islamic civilization's contribution to the development of the scientific method and experimental medicine and following the landmark trials, models of meticulousness in design and implementation that paved the way to the discipline of clinical trials to grow in sophistication and influence, leading to the flourishing of medical advancements of the present times

METHODOLOGY

This thesis aims to capture the major milestones in the evolution of clinical trials by shedding the lights on the Islamic civilization's contribution to the development of the scientific method and experimental medicine. It aims also to highlight the influence of Islamic civilization on Western Europe, laying the basis to the Renaissance movement.

The current project is a bibliographic research thesis. It covers a period of several centuries, starting from the ancient Greece, mainly focusing on the era of Islamic civilization, passing by the Renaissance period and the age of lights in Europe and finally taking a peek on the development of clinical trials in the post- light era period.

For data processing, we used a Qualitative research, which involves collecting and analyzing numerical and non-numerical data (e.g., text, video, and audio) to understand concepts, opinions, and experiences concerning the evolution of medical thinking through clinical trials.

For data examination and interpretation, we used document analysis in order to elicit meaning, gain understanding, and develop empirical knowledge.

The analytical procedure entailed finding, selecting, appraising, and synthesizing data contained in documents. The data collected was, then organized into two major chapters: "Islamic Civilization and medical thinking" and "The evolution of clinical trials in western civilization".

Our document analysis drew upon multiple (at least two) sources of evidence. By doing so, we sought convergence and corroboration through the use of different data sources in order to provide a confluence of evidence that reduce the impact of potential biases that can exist in a single study and thus to breed credibility.

Throughout our analysis, we tried to determine the authenticity, credibility, accuracy, and representativeness of the selected documents. So we drew data from the main, well known and credible authors with backgrounds from both Islamic and western civilizations.

The used data are remarkably spawned by some of the state-of- the art and specialized journals such as, to name only a few, the Journal of the International Society for the History of Islamic Medicine and the Journal of the Royal society of Medicine.

A great deal of invaluable articles and to the point contents were provided by e-libraries such as James Lind library, The Stanford Encyclopedia of Philosophy, and Encyclopedia Britannica.

In this thesis we followed the evolution of medical thinking subsumed under two civilizations: the Islamic Civilization and the Western Civilization. The main focus has been placed on the study of medical thinking advancements embedded to Islamic Civilization. To do so, we followed four approaches:

- The institutional approach where we focused on 3 institutions that greatly influenced the medical practice: hospitals, libraries and the institutionalizing of physicians licensing.
- The theological approach addresses the role Islam played in creating a whole new scientific perspective as a religion based on seeking knowledge.
- The medical approach where we saw how Medieval Islamic medicine introduced several aspects of medical research which anticipated modern clinical trial designs .
- The philosophical approach builds upon the evolution of natural philosophy within the Islamic Empire and how it influenced both Islamic and Western civilizations by laying the foundations of empiricism.

PART I:

Islamic Civilization and Medical Thinking

Islamic medicine, in its true context, can thus be defined as a body of knowledge of medicine that was inherited by the Muslims in the early phase of Islamic History (40-247 AH/661-861 AD) from mostly Greek sources, but to which became added medical knowledge from, Persia, Syria, India and Byzantium. This knowledge was not only to become translated into Arabic, the literary and scientific lingua franca of the time, but was to be expounded, assimilated, exhaustively added to and subsequently codified, and 'Islamized'. The physicians of the times both Muslim and non-Muslim were then to add to this, their own observations and experimentation and convert it into a flourishing and practical science, thus helping in not only curing the ailments of the masses, but increasing their standards of health. The effects of its domineering influence extending not only in the vast stretches of the Islamic lands, but also in all adjoining nations including Europe, Asia, China, and the Far East. The span was measurable not only for few centuries, but also perhaps for an entire millennium, 610 to 1610 AD. During which time, Europe and rest of the extant civilized nations of the world were in the grip of the 'dark ages'. It also set the standards of hygiene, and preventative medicine and thus was responsible for the improvement of the general health of the masses. It was to hold sway until decadence finally set in, concomitant with the political decline of the Islamic nation. With the advent of the Renaissance in Europe, at the beginning of the 17th century AD, it was finally challenged by the new and emerging science of modern medicine, which was to finally replace it in most of the countries, including the countries of its birth![1]

[1]Nagamia, (2003), "Islamic Medicine History and Current Practice", *ISHIM*, Vol 2, (Ed, Demirhan Erdemir and Kaadan), Istanbul, Nobel Tip Kitabevleri.

I-Historical Background

The Arab penetration of the Middle East and North Africa in the seventh century A.D. did not destroy the intellectual life of the conquered lands. By a selective process of assimilation, Islamic society came to embody significant elements of Hellenistic culture. This continuity can be seen most vividly in Islamic art and architecture. In a less visible but no less important form, it can be seen in the philosophic and scientific tradition that flourished in medieval Islamic society. Despite an early acquaintance with the scientific achievements of other cultures, notably of India, it was the Greek tradition that was decisive for Islamic learning[2].

1. Hellenistic Influence

The predominance of the Greek tradition was largely due to the Hellenized Christians, Jews, and Persians, who made up the bulk of the population in the newly established empire, and to the persistence of their centers of learning.

The transmission of the Greek scientific tradition during the early Islamic empire was complemented on a more popular level by the infiltration of Greek ideas into Islamic culture via the educated, non-specialist classes. The nascent Islamic society revived the Greek heritage and was quite receptive to Greek thoughts, the ideas of these newly converted, educated peoples, as can be seen by the infusion of Greek ideas into early Muslim law and theology. Similarly, the Greek philosophical heritage continued uninterrupted "in a more or less underground way," especially skepticism, and, which was never truly assimilated, because it was pagan[3].

Of all the ancient medical authors, Galen and Hippocrates had the greatest influence upon the medieval medicine. The most well-known of all the physicians of

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[2]Dols, Gamal, (1984), *Medieval Islamic Medicine*, Berkley and L.A, University of California Press, pp3-4
[3]Ibid

ancient Greece was Hippocrates but later Hellenistic doctors promoted the works of Galen, seeing in him the highest development of the Hippocratic art and of medical science. Both his comprehensiveness and his philosophic interests made his work congenial to medieval philosopher-physicians.

1.1. Hippocrates

Anyone attempting a biography of Hippocrates would find very little to be certain about, especially following the more recent historical biographies that follow the modern iconoclastic trend, rather than the older, often hagiographic one. Very little information has passed down to us about his life. We do not even know what he looked like, as it is almost definite that the statues purported to represent him are fictional depiction and not a true image. Some of the stories recounted by ancient writers and historians have been investigated by modern scholars and may be true, while others are shrouded in myth. Yet, there is no doubt that he existed and was indeed the most successful physician of his time. Plato, the founder of the Academy of Athens, who often criticized the work of doctor-practitioners in Ancient Greece, calls Hippocrates: '*the famous physician of Kos'* in his dialogue *'Prot1agoras'*.[4]

'The Great Hippocrates, the wise physician' as Aristotle calls him in his book *Politics*, was obviously an unusual man, even for the enlightened era in which he lived. Born into a family of priests-doctors, he was taught by his physician-priest father Heraclides and his grand-father Hippocrates. At that time, anyone could become a self-proclaimed physician (*ιητρός*) without having to go through any kind of structured training, provided he was born into a family of doctors. Medicine was a 'closed occupation', practiced mainly by priests in the temples, the Asklepeiia. Consequently, medical practice was, more often than not, mixed with magical,

[4]Tsiompanou , Marketos (2012). Hippocrates: timeless still. *JLL Bulletin: Commentaries on the history of treatment evaluation (https://www.jameslindlibrary.org/articles/hippocrates-timeless-still/)*

supernatural and superstitious elements. Hippocrates did not believe that illnesses were God-sent. Furthermore, he was not content to just preserve the traditional practice of his ancestors. He was exceptional in that he broke the long-standing tradition of keeping the occupation within the family. He established the School of Kos where he taught medicine for a fee to outsiders who wanted to learn 'the Art' and were prepared to abide by the rules described in the Hippocratic Oath[5].

Between 440-360 BC (approx) Hippocrates wrote a number of medical treatises and his pupils probably wrote many more. Only sixty treatises were saved from the fire that destroyed the Great Library of Alexandria around the end of the 2nd century AD. The surviving texts were compiled, possibly by an Alexandrian librarian, and published under the title *Corpus Hippocraticum*. The authorship of the books in the Corpus continues to be the subject of archaeological and historical research and debate. Although some of the books may not be Hippocrates' own writings, it is nevertheless agreed that all display his influence[6].

1.1. a. The need to review the evidence

In his text *Ancient Medicine* Hippocrates was critical of his predecessors for being inadequately prepared to practice medicine:

"All those who have taken as their task to speak or write about medicine and are using a hypothesis for their thesis, such as hot or cold, wet or dry or anything else similar being the cause of illness and death in human beings, clearly are wrong in what they say, as they reduce the causes of diseases to one or two factors. But their fault is especially grave, as their mistakes have to do with a real art, which people use in the most important circumstances and whose good practitioners are

[5] Tsiompanou , Marketos (2012)
[6] ibid

especially honored by all. Some of these practitioners are bad, while others are much better"[7].

However, he acknowledged that not everything was wrong and that there had been useful discoveries made before him. He therefore instructed doctors to review and analyze all pre-existing data before embarking on any research. This method of inquiry, he said, was and always had been the only acceptable way of finding answers in medicine, as it helped physicians with good training and inquisitive minds to focus their attention on what had not yet been discovered:

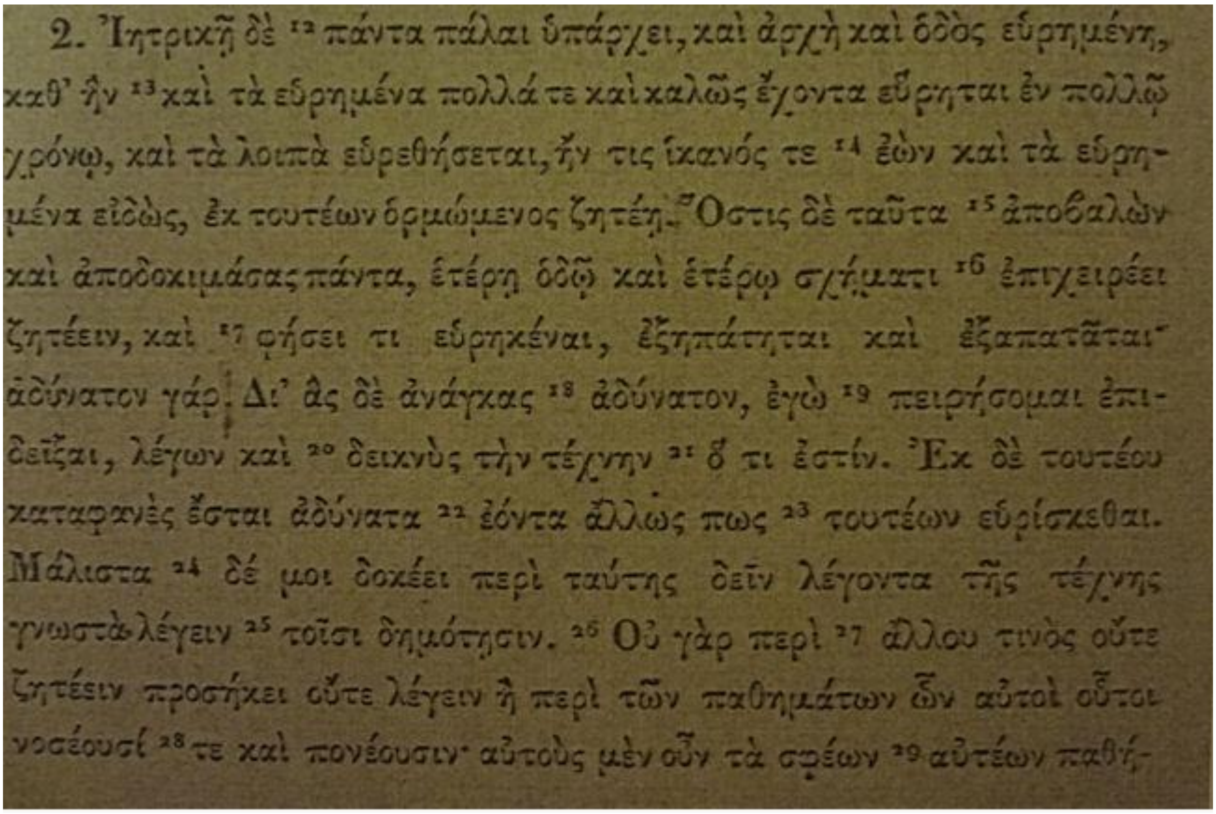
2. Ἰητρικῇ δὲ [12] πάντα πάλαι ὑπάρχει, καὶ ἀρχὴ καὶ ὁδὸς εὑρημένη, καθ' ἣν [13] καὶ τὰ εὑρημένα πολλά τε καὶ καλῶς ἔχοντα εὕρηται ἐν πολλῷ χρόνῳ, καὶ τὰ λοιπὰ εὑρεθήσεται, ἤν τις ἱκανός τε [14] ἐὼν καὶ τὰ εὑρημένα εἰδὼς, ἐκ τουτέων ὁρμώμενος ζητέῃ. Ὅστις δὲ ταῦτα [15] ἀποβαλὼν καὶ ἀποδοκιμάσας πάντα, ἑτέρῃ ὁδῷ καὶ ἑτέρῳ σχήματι [16] ἐπιχειρέει ζητέειν, καὶ [17] φήσει τι εὑρηκέναι, ἐξηπάτηται καὶ ἐξαπατᾶται· ἀδύνατον γάρ. Δι' ἃς δὲ ἀνάγκας [18] ἀδύνατον, ἐγὼ [19] πειρήσομαι ἐπιδεῖξαι, λέγων καὶ [20] δεικνὺς τὴν τέχνην [21] ὅ τι ἐστίν. Ἐκ δὲ τουτέου καταφανὲς ἔσται ἀδύνατα [22] ἐόντα ἄλλως πως [23] τουτέων εὑρίσκεσθαι. Μάλιστα [24] δέ μοι δοκέει περὶ ταύτης δεῖν λέγοντα τῆς τέχνης γνωστὰ λέγειν [25] τοῖσι δημότῃσιν. [26] Οὐ γὰρ περὶ [27] ἄλλου τινὸς οὔτε ζητέειν προσήκει οὔτε λέγειν ἢ περὶ τῶν παθημάτων ὧν αὐτοὶ οὗτοι νοσέουσί [28] τε καὶ πονέουσιν· αὐτοὺς μὲν οὖν τὰ σφέων [29] αὐτέων παθή-

Figure 1 : Jones WHS (1923), A quote from Hippocrates' Ancient Medicine.

"… full discovery will be made, if the inquirer be competent, conduct his researches with knowledge of the discoveries already made, and make them his

[7]Jones WHS (1923). *Hippocrates*. Volume I. With an English Translation by WHSJ. Cambridge, Mass & London: Loeb Classical Library. Cited in *Tsiompanou , Marketos (2012)*

starting-point; but anyone who, casting aside and rejecting all these means, attempts to conduct research in any other way or after another fashion, and asserts that he has found out anything, is and has been, the victim of deception"[8].

This clear Hippocratic instruction brings to mind today's call for systematic reviews, a necessary first step to establishing what is already known and uncovering areas that need further exploration. A plethora of research studies and publications in a large number of journals means that systematic reviews are more important nowadays than ever before. Modern scientists agree that failure to review pre-existing data can have negative consequences, sometimes fatal[9].

1.1. b. Choosing the right treatment

Hippocratic doctors considered each person to be unique and therefore adapted their advice, paying particular attention to the characteristics of each person (age, gender, appearance and physique), their daily habits, the place they lived in and the season of the year. They were helped to decide on their prescribed treatment by their past experience of treating similar cases:

"..the physician sets about his task (of prescribing treatment) with healthy mind and healthy body, having considered the case and past cases of like characteristics to the present, so as to say how they were treated and cured."[10]

Then, as today, physicians often had to face uncertainty in their practice when choosing the right treatment for their patients. During a historical period of very limited access to written literature, Hippocratic doctors used what we would now call grade IV evidence (that is, anecdotal, based on personal experience) to guide their clinical decisions. In the 21st century, modern doctors can rely on more robust

[8] Littré MPE (1839). Œuvres complètes d'Hippocrate, vol 1. Paris: J-B Bailliere, p572. Translated by Tsiompanou

[9] Tsiompanou and Marketos, (2012)

[10] Jones (1923) cited in Tsiompanou and Marketos (2012)

evidence in their daily practice[11]. Even so, they continue to be influenced by their clinical experience, not least in avoiding doing harm to patients[12].

1.1.c. The Art of Medicine and Writing

An aspect of Hippocratic Medicine that was innovative at the time relates to the practice of collecting detailed records of the patients Hippocrates cared for. This practice marked a significant shift from the then traditional oral transmission of knowledge. Plato commented on this new movement of the written word, in his work *Phaedrus*:

"For this [the art of writing] *will cause forgetfulness in the minds of those who have learned, because they will neglect* their *memory. Having put their trust in writing, they will recall to memory things from outside, by means of external marks; not from inside themselves, by themselves. You have invented a pharmakon not for memory, but for reminding.*"[13]

Perhaps these records were used for teaching purposes. We do not really know what their purpose was. Hippocrates challenged the then oral tradition, by recording his observations. When a person came to see him about their illness, he examined details about their habits, lifestyle, food intake and their symptoms and signs of disease. With his companions and disciples, he recorded his findings, analyzed them and later developed his theories. Through this system, which was based on clinical observation, he drew original conclusions and pushed medicine forward to a new era, influencing physicians more than anyone else before him[14].

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[11]Darzi A (2008). Evidence-based medicine and the NHS: a commentary. J R Soc Med 101:342-344.
[12]Stuebe AM (2011). Level IV evidence–adverse anecdote and clinical practice. New Engl J Med 365:8-9.
[13]Plato, Phaedrus 275a. In: Totelin LMV (2009) Hippocratic Recipes: Oral and Written Transmission of Pharmacological Knowledge in Fifth- and Fourth-Century Greece, Leiden: Brill, p 1. Cited in Tsiompanou and Marketos, (2012)
[14]Tsiompanou and Marketos, (2012)

1.2. Galen

Galen, Greek Galenos, Latin Galenus, (born 129 CE, Pergamum, Mysia, Anatolia [now Bergama, Turkey]—died c. 216 CE), Greek physician, writer, and philosopher who exercised a dominant influence on medical theory and practice in Europe from the Middle Ages until the mid-17th century. His authority in the Byzantine world and the Muslim Middle East was similarly long-lived.

1.2.a. Early Life and Training

Galen was born into the intellectual and social elite of the culturally Greek city of Pergamum (near the northwest coast of Roman Asia, in present-day Turkey) in 129 CE.

From the age of sixteen, he undertook an educational journey of several years, involving periods in Smyrna, Corinth and Alexandria, to study with the foremost medical teachers of the time. This study also involved a strong textual element, and—alongside actual anatomy (for which Alexandria remained a major center, although dissection at this period was restricted to non-human animals)—Galen acquired an in-depth knowledge of the medical, as well as the philosophical, writings of his predecessors[15].

In 157 he returned to his home city, taking up an official post as doctor to the gladiators, before moving to Rome in the early 160s, where—after one more brief period back in Pergamum—he settled permanently. There he quickly rose in the medical profession owing to his public demonstrations of anatomy, his successes with rich and influential patients whom other doctors had pronounced incurable, his enormous learning, and the rhetorical skills he displayed in public debates. Galen's wealthy background, social contacts, and a friendship with his old philosophy teacher Eudemus further enhanced his reputation as a philosopher and physician[16].

[15] Singer, (2016), "Galen", *The Stanford Encyclopedia of Philosophy*, Edward N. Zalta (ed.), URL = <https://plato.stanford.edu/archives/win2016/entries/galen/>.
[16] Ibid

Galen abruptly ended his sojourn in the capital in 166. Although he claimed that the intolerable envy of his colleagues prompted his return to Pergamum, an impending plague in Rome was probably a more compelling reason. In 168-169, however, he was called by the joint emperors Lucius Verus and Marcus Aurelius to accompany them on a military campaign in northern Italy. After Verus' sudden death in 169, Galen returned to Rome, where he served Marcus Aurelius and the later emperors Commodus and Septimius Severus as a physician. Galen's final works were written after 207, which suggests that his Arab biographers were correct in their claim that he died at age 87, in 216/217[17].

1.2.b. Anatomical and Medical Studies

Galen regarded anatomy as the foundation of medical knowledge, and he frequently dissected and experimented on such lower animals as the Barbary ape (or African monkey), pigs, sheep, and goats. Galen's advocacy of dissection, both to improve surgical skills and for research purposes, formed part of his self-promotion, but there is no doubt that he was an accurate observer. He distinguished seven pairs of cranial nerves, described the valves of the heart, and observed the structural differences between arteries and veins. One of his most important demonstrations was that the arteries carry blood, not air, as had been taught for 400 years. Notable also were his vivisection experiments, such as tying off the recurrent laryngeal nerve to show that the brain controls the voice, performing a series of transactions of the spinal cord to establish the functions of the spinal nerves, and tying off the ureters to demonstrate kidney and bladder functions. Galen was seriously hampered by the prevailing social taboo against dissecting human corpses, however, and the inferences he made about human anatomy based on his dissections of animals often led him into errors. His anatomy of the uterus, for example, is largely that of the dog's[18].

[17]Nutton, (2020), "Galen", *Encyclopædia Britannica*,URL:<https://www.britannica.com/biography/Galen>
[18]Ibid

Galen’s physiology was a mixture of ideas taken from the philosophers Plato and Aristotle as well as from the physician Hippocrates, whom Galen revered as the fount of all medical learning. Galen viewed the body as consisting of three connected systems: the brain and nerves, which are responsible for sensation and thought; the heart and arteries, responsible for life-giving energy; and the liver and veins, responsible for nutrition and growth. According to Galen, blood is formed in the liver and is then carried by the veins to all parts of the body, where it is used up as nutriment or is transformed into flesh and other substances. A small amount of blood seeps through the lungs between the pulmonary artery and pulmonary veins, thereby becoming mixed with air, and then seeps from the right to the left ventricle of the heart through minute pores in the wall separating the two chambers. A small proportion of this blood is further refined in a network of nerves at the base of the skull (in reality found only in ungulates) and the brain to make psychic pneuma, a subtle material that is the vehicle of sensation. Galen’s physiological theory proved extremely seductive, and few possessed the skills needed to challenge it in succeeding centuries[19].

[19]Nutton, (2020)

Figure 2: Galen and Hippocrates: Galen of Pergamum, left, with Hippocrates on the title page of Lipsiae, a medical book by Georgii Heinrici Frommanni, (1677)

Building on earlier Hippocratic conceptions, Galen believed that human health requires an equilibrium between the four main bodily fluids, or humours—blood, yellow bile, black bile, and phlegm. Each of the humours is built up from the four elements and displays two of the four primary qualities: hot, cold, wet, and dry. Unlike Hippocrates, Galen argued that humoral imbalances can be located in specific organs, as well as in the body as a whole. This modification of the theory allowed doctors to make more precise diagnoses and to prescribe specific remedies to restore the body's balance. As a continuation of earlier Hippocratic conceptions, Galenic physiology became a powerful influence in medicine until the 11th century[20].

[20] Nutton, (2020)

Galen was both a universal genius and a prolific writer: about 300 titles of works by him are known, of which about 150 survive wholly or in part. He was perpetually inquisitive, even in areas remote from medicine, such as linguistics, and he was an important logician who wrote major studies of scientific method. Galen was also a skilled polemicist and an incorrigible publicist of his own genius, and these traits, combined with the enormous range of his writings, help to explain his subsequent fame and influence.

1.2.c. Influence

Galen's writings achieved wide circulation during his lifetime, and copies of some of his works survive that were written within a generation of his death. By 500 CE his works were being taught and summarized at Alexandria, and his theories were already crowding out those of others in the medical handbooks of the Byzantine world. Greek manuscripts began to be collected and translated by enlightened Arabs in the 9th century, and about 850 Ḥunayn ibn Isḥāq, an Arab physician at the court of Baghdad, prepared an annotated list of 129 works of Galen that he and his followers had translated from Greek into Arabic or Syriac. Learned medicine in the Arabic world thus became heavily based upon the commentary, exposition, and understanding of Galen[21].

Galen's influence was initially almost negligible in Western Europe except for drug recipes, but from the late 11th century Ḥunayn's translations, commentaries on them by Arab physicians, and sometimes the original Greek writings themselves were translated into Latin. These Latin versions came to form the basis of medical education in the new medieval universities[22].

[21]Nutton, (2020)
[22]Ibid

1.3. Galenism

Thanks to the translation of classical works as well as to numerous summaries and commentaries, the doctors of the Islamic era had available every work by Hippocrates and Galen that was still being read in the Greek centers of learning during the seventh to ninth centuries A.D. Subsequently, many of these Arabic translations, augmented by the significant additions of Arabic authors, were translated into Latin from the late eleventh century A.D. and had a profound effect on the intellectual life of Europe in the High Middle Ages. The Latin translations of Arabic medical works transplanted Galenism to the West, where it became deeply rooted until modern times[23].

Late Hellenistic doctors promoted the works of Galen, seeing in him the highest development of the Hippocratic art and of medical science. Like the contemporary development of Christianity in the religious life of late antiquity, Galenism greatly narrowed ancient tradition: where there had once been lively debate, now there was a single strong voice. Not surprisingly, the works of Galen were conspicuous among Greek medical texts translated during the Islamic era. Paradoxically, the tradition of Hippocrates only followed in the shadow of Galen. Although medieval physicians greatly esteemed Hippocrates, his works did not attract the interest of translators and their patrons as Galen's did. The Arabic versions of Hippocrates' works were derived almost entirely from the translated works of Galen and other late Hellenistic writers. These secondary works digested the difficult Hippocratic writings in simpler and briefer form and refashioned them in the Galenic spirit. As Ibn Ridwan said, "Galen refined the teaching of Hippocrates and made the art [*sina'ah*] of medicine easy and comprehensible for people of outstanding talent who desire it."[24]

[23]Dols, Gamal, (1984), *Medieval Islamic Medicine*, University of California Press, Berkley and LA, pp8-10
[24]ibid

The essence of the Galenic system, humoral pathology, had originated with the Hippocratic School. It had been modified by other medical schools and especially by Aristotle, whose influence on medical theory, such as psychology, was decisive. Galen molded this notion of humors into a comprehensive theory. He conceived of *all* things as composed of the four elements of fire, earth, air, and water, embodying the four qualities of hot, cold, dry, and wet. Food and drink, like everything else, consisted of these basic elements and their qualities; the physician was responsible for knowing their attributes, as well as those of simple and compound drugs. In the process of digestion in the stomach, food and drink were transformed (literally "cooked") by natural heat into different substances (Ar. *banat al-arkan,* "the daughters of the elements"). Four humors (Ar. *al-akhlat)* resulted: blood, phlegm, yellow bile, and black bile. Air corresponded to blood, which is hot and wet; water to phlegm, which is cold and wet; fire to yellow bile, which is hot and dry; and earth to black bile, which is cold and dry. After another "cooking" in the liver, a portion of these substances was transported by the blood to the various organs of the body to nourish them, while the rest was excreted. Galen believed that the bodily parts and their actions resulted from varying combinations of these four elements, qualities, and humors. The precise proportions in which the qualities were combined were very important; the proper *krasis* (Ar.*mizaj*) temperament or blending, produced health[25].

The equilibrium of the four qualities, therefore, created wellbeing. In Greek medicine this balance was termed *eukrasia,* literally "the state of being well mixed," or *symmetria;* both terms had strong philosophical and ethical connotations. In Arabic medicine this notion was usually translated as *i'tidal (al-mizaj)* and retained the classical connotations. If there was too much or too little of a humor, the balance was upset, and *eukrasia* was displaced by *dyskrasia* (Ar. *su'al-miziij* or *kharij 'an al-i'tidal).*

[25]Dols, Gamal, (1984), p.11-12

The result was illness, the particularity of which depended on the affected humor. Sickness was also caused by changes in the normal qualitative makeup of the humors, the tissues and organs, or the spirits[26].

The etiological agent in Greek medicine was thus considered to be either a quantitative or a qualitative change of a humor; in the latter case, putrefaction rendered the humor pathogenic. Galen distinguishes, therefore, between a superabundance of humors, constituting a plenitude, and a qualitative change in the humors. These bodily surpluses could be eliminated by a wide variety of activities aside from normal excretion, such as gymnastics, bathing, coition, purges, and external medications[27].

Not every deviation from the balance of the humors was considered an illness. Where the Hippocratic School proposed the existence of an ideal equilibrium, Galen argued that there was a wide latitude of health, ranging from the ideal to the chronically sick. Exterior factors, such as climate, occupation, and the season of the year, made one of the four humors dominate in every human body. This gave a man his individual habits and complexion, his disposition, which might be sanguine, phlegmatic, choleric, or melancholic. Thus, the humoral doctrine was applied not only to the causes and course of illness but also to the analysis of the constitutional variations of healthy people[28].

The keystone of the Galenic system was the maintenance or restoration of *eukrasia.* Man could protect his health by moderation, by conserving symmetry in the different spheres of his life. The doctor's duty was to teach his patients the proper regimen for their bodies according to their individual circumstances[29].

[26] Dols, Gamal, (1984), p.11-12
[27] Ibid
[28] Ibid
[29]Dols, Gamal, (1984), p.16

Medieval doctors made the four humors canonical and defined them more precisely, particularly the phlegmatic "and sanguine humors, about which Galen had been ambiguous. Exemplifying the elaboration of Galenic theory is the considerable refinement of the idea that insanity was caused by the humors; the discussions of the Islamic doctors greatly influenced the Western interpretation of insanity. Generally, medieval Galenism perpetuated the view of the Dogmatists, who in ancient medicine had attempted to create an exact science of medicine on the basis of the largely empirical writings of Hippocrates. Through philosophic speculation, the Dogmatists formulated a priori principles or *dogmata* of medical knowledge and deduced treatments from these principles. The Empiricists, conversely, rejected the possibility of a scientific basis for medicine; they relied instead on observation and experience and used the inductive method. Islamic medicine inherited this intellectual contention, and it continued to evoke discussion. In Islamic medicine, however, the Dogmatists and the Empiricists were not two rival schools, but represented complementary orientations or emphases, both of which could be found in the works of Galen[30].

2. The Birth of the Islamic Empire

In order to understand the period in which Islamic medicine was born, one has to understand the salient events in the advent of Islam and a few events just preceding the Islamic era. Arabia, which was a large area covered mostly by arid desert that was roamed by nomadic tribes of Bedouins. Certain communities had been established where the trade routes intersected and water was available. Mecca was along the Yemen-Damascus trade route. It was considered a holy city and a sanctuary. The

[30]Dols, Gamal, (1984), p.21

Kaaba or house of worship was replete with idols of different gods each representing a tribe or community. These Bedouins had their own tribal moral or ethical codes of conduct and idolatry was in practice. Blood feuds were common and attacking caravans along trade routes was a way of life. Sacrifices were often offered to appease the gods and burying of live female children was common practice. Family feuds were common and settling scores in order to uphold tribal honor led to frequent bloody encounters in which many people were killed. Women and children were treated as 'chattels' or private possessions and became the property of the winner[31].

This era of Arabia is frequently referred by Muslims as *'Jahilliya'* or age of ignorance. Islam was not only to bring dramatic changes in the religious practices of these warring nomadic tribes but also unite them into an unprecedented social and cultural nation that very quickly was to develop into a strong political entity, with its own system of administration, justice, and military power, all under one leadership. The first leader of the Islamic State was no doubt the Prophet of Islam, Mohammed but then his four successors called the '*Pious Caliphs'* were to quickly to consolidate and expand the nation. Within one hundred years of coming into existence, the Islamic empire had spread from Spain in the West, to China in the East, and encompassed in its midst, the whole of Northern Africa, Egypt, Syria, Palestine, Transjordan, Central Asia and parts of Western India[32].

Later it was to be even carried further by the Muslim merchants to the shores of the Far-East including the Malaysian peninsula, the islands of the East Indies and Indonesia. In its early era and for several centuries, the Islamic empire was centrally governed by a leader or 'Caliph' and administered by provincial governors. The first four Caliphs were elected democratically but the later Caliphate became dynastic.

[31]Nagamia, (2003)
[32]Ibid

Later still a western Caliphate was established in Spain. In later history the Islamic Nation was to break up into various kingdoms, as the provincial rulers become more autonomous and independent of the center and was ultimately to be overrun by the Seljuk Turks who were the forerunners of the Ottoman Empire[33].

It was during the early Caliphates of the 'Ummayads' and the 'Abbasids' that the maximum development of Islamic Medicine took place. It was also during this time and under the patronage of these Caliphs that the great physicians both Muslim and non-Muslim thrived, accumulated the wealth of medical knowledge and cultivated a system of medicine that was to be later called 'Islamic Medicine'.

3. The early era of Islamic Medicine and the School of Medicine at Jundishapur:

Jundishapur or 'Gondeshapur' was a city in Khuzistan founded by a Sassanid emperor Shapur I (241-272 AD) before the advent of Islam. It was to settle Greek prisoners, hence the name 'Wandew Shapur' or 'acquired by Shapur.' In present day Western Persia the site is marked by the ruins of Shahbad near the city of Ahwaz. The town was taken by Muslims during the caliphate of Umar Ibn Alkhattab, by Abu Musa Al-Ashari in (17 AH/738 AD). At this time it already had a well-established Hospital and Medical school[34].

Many Syrians took refuge in the city when Antioch was captured by Shapur I. In fact the latter nicknamed the city 'Vehaz-Andevi Shapur' or 'Shapur is better than Antioch.' The closing of the Nestorian School of Edessa by Emperor Zeno in 489 AD led to the Nestorians fleeing from there and seeking refuge in Jundishapur under the patronage of Shapur II, which got an academic boost as a result. The Greek influence was already predominant in Jundishapur when the closing of the Athenian school

[33]Nagamia, (2003)
[34]Ibid

in 529 AD by order of the Byzantine emperor Justinian drove many learned Greek physicians to this town. A University with a medical school and a hospital were established by Khusraw Anushirwan the Wise (531-579 AD) where the Greeco-Syriac medicine blossomed. To this was added medical knowledge from India brought by the physician vizier of Anushirwan called 'Burzuyah.' On his return the latter brought back from India the famous 'Fables of Bidpai', several Indian Physicians, details of Indian Medical Texts and a Pahlavi translation of 'Kalila and Dimna.' Khusraw was even presented a translation of Aristotelian logic and philosophy. Thus at the time of the Islamic event the school of Jundishapur was well established and had become renowned as a medical center of Greek, Syriac and Indian learning. This knowledge had intermingled to create a highly acclaimed and state of the art Medical school and hospital. After the advent of Islamic rule the University continued to thrive. In fact the first recorded Muslim Physician Harith bin Kalada, who was a contemporary of the Prophet acquired his medical knowledge at the medical school and hospital at Jundishapur[35].

It is likely that the medical teaching at Jundishapur was modeled after the teaching at Alexandria with some influence from Antioch but it is important to note that 'the treatment was based entirely on scientific analysis, in true 'Hippocratic tradition', rather than a mix-up with superstition and rituals as was the case in Greek 'Asclepiea' and Byzantine 'Nosocomia'. This Hospital and medical Center was to become the model on which all later Islamic medical schools and Hospitals were to be built. The school none the less thrived during the Ummayad caliphate and Sergius of Rasul'ayn translated medical and philosophical works of both Hippocrates and Galen into Syriac. These were later to be translated into Arabic casting an everlasting imprint onto all the future of Islamic medicine[36].

[35]Nagamia, (2003)
[36]Ibid

It was during the Abbasid Caliphate that Caliph al-Mansur the founder of the city of Baghdad invited the then head of the Jundishapur School to treat him. This physician was Jirjis Bukhtyishu, a Christian whose name meant ‘Jesus has saved’. He treated the Caliph succesfully and was appointed to the court. However, he did not stay permanently in Baghdad returning to Jundishapur before his death, but the migration to Baghdad had begun. Thus his son Jibrail Bukhtishu established a practice in the city and became a prominent physician. Another family that migrated from Jundishapur to Baghdad was the family of Masawayh who came at the invitation of Caliph Harun-al-Rashid and became a famous Ophthalmologist. Most famous amongst his three sons, who were physicians, was Yuhanna ibn Masawayh (Mesue Senior). He wrote prolifically and 42 works are attributed to him. By this time, i.e. the second half of 2nd century after hijra (8th century AD), the fame of Baghdad began to rise as also did the political power of the caliphate. Many hospitals and medical centers were established and tremendous intellectual activity was recorded. This culminated into the period of the Islamic Renaissance and the golden era of Islamic Medicine[37].

4. The resources for development of Islamic Medicine: The Bait-ul-Hikma or ‘The House of Wisdom’

‘Bait-ul-Hikma’ or House of Wisdom was founded in 214 AH 830 AD by the Caliph Al-Mamun an Abbasid Caliph. *Ibn Al Nadim*, who was the son of a bookseller and whose famous catalogue of books ‘Firhist of Nadim’ tells us of many of the Books of his time. It is related of this Caliph: that Aristotle appeared in the dream of the learned Caliph and told him that there was no conflict between reason and revelation. The Caliph thus set about searching for books and manuscripts of the

[37]Nagamia, (2003)

ancient Greek philosophers and scientists. He sent an emissary to the Byzantine Emperor to get all the scientific manuscripts that were apparently stored in an old and dilapidated building. After initially turning him down, the emperor granted him his request. Among the emissaries sent to select the works was the first director of the house of wisdom Salman, who was the one that led the delegation. Others in it were al Hajjaj Ibn Matar and Ibn al Batrik. They brought back with them many Greek scientific works and manuscripts. Translations of all of these were immediately started. However the translation of the medical works of the Greeks had started earlier during the reign of Caliph Harun al Rashid, with the building of the first hospital under the Caliph's patronage[38].

Ibn Nadim lists 57 translators associated with the House of Wisdom. The ones who formed the first delegation to the Byzantine ruler have already been named. Other famous ones are as follows:

1. Al Hajjaj ibn Yusuf ibn Matar completed translation of Euclid's elements. Other Greek authors including Aristotle, Archimedes, Pythogras, Theodesius, Jerash, Apollonius, Theon and Menelaus all were translated.
2. Muhammad ibn Musa al-Khwarizimi born in Khiva systematically explored arithmetic and algebra. The latter derived its name from his discourse: '*Kitab al-Jabr wa al-Muqabla*.' Algebra was derived from the second word and meant 'bone setting' a graphic description of operations on solving quadratic equations[39].
3. The knowledge of geometry flourished and with it architecture and design. Ibn Khaldun was later to describe geometry as a science that 'enlightens the intelligence of man and cultivates rational thinking.

[38]Nagamia, (2003)
[39]Ibid

4. Mamun's court astronomer was Musa ibn Shakir. His three sons Muhammad, Ahmad and al-Hassan devoted their lives to the search of knowledge. They exemplified the Prophetic traditions and dicta: '*Seek learning even if it be in China.*' '*The search for knowledge is obligatory on every Muslim.*' '*The ink of scholars is worth more than the blood of martyrs.*' The works of these learned men or 'Sons of Musa" were exceptionally creative. They wrote on: celestial mechanics, the atom, the origins of earth, the Ptolemaic universe, the properties of the ellipse, planes and spheres, the knowledge of geometry served in practice to create canals, bridges and architectural designs[40].
5. Muhammad ibn Musa on one of his travels met Thabit ibn Qurra. The latter was a master of three languages. Greek, Syriac and Arabic, and soon got appointed to become the court astronomer to Caliph al-Mutadid. He was an invaluable addition to the House of Wisdom. In 70 original works he wrote on every conceivable subject including mathematics, astronomy astrology, ethics, mechanics, physics, and philosophy. He also published commentaries on Euclid, Ptolemy, and other Greek thinkers and philosophers.
6. The two sons of Thabit ibn Qurra also became famous. Sinan was a famous physician in Baghdad. He was director of several hospitals and was court physician to three successive caliphs. His son Ibrahim also became a prominent scientist. He invented sundials and wrote a special treatise on this subject[41].
7. The greatest medical mind in the House of Wisdom was Hunain ibn Ishaq. Born in Hira Hunain was the son of an apothecary. He soon translated an entire collection of Greek medical works including Galen and Hippocrates. Hunain was an extremely gifted and talented translator. From being just a literal translator he tended to be

[40] Nagamia, (2003)
[41] Ibid

more scientific and duly interpreted the original text by cross reference, annotation and citing glossaries. His original contributions included 10 works on ophthalmology which were extremely systematic. He rose to the highest honor by being appointed the director of the House of Wisdom by Caliph al Mutawakkil[42].

8. Qusta ibn Luqa was another accomplished translator and scholar. He has 40 original contributions to his credit. He wrote on diverse subjects such as 'mirrors, hairs, fans, winds, logic, geometry and astronomy to name a few[43].
9. Yuhanna ibn Masawaih (Mesuse senior) was an early director of the House of Wisdom. He served under four caliphs: al Mamun, al-Mutassim, al-Wathik and al-Mutawakkil. He wrote about medical, and especially gynecological problems.

The effects of the House of wisdom were tremendous. Islamic science, philosophy, art and architecture all felt its effects. Agriculture, Government, prosperity and economic wealth were the benefactors. It was ultimately responsible for producing figures like Al-Kindi and Al-Farabi, plus some of the greatest thinkers, scientists and philosophers of Islam. Also some of the greatest Islamic physicians had available to them all the knowledge of ancient Egypt, ancient Greece, Syria, India and Persia and in their turn, they contributed by their astute observation and originality[44].

II- The great physicians of Islamic Medicine

The era of Islamic medicine produced some very famous and notable physicians. These physicians were not only responsible for gathering all the existing information on the medicine of the time, but also for adding to this knowledge by their own astute observations, experimentation and skills. Many of them were skilled in medical writing

[42]Nagamia, (2003)
[43]Ibid
[44]Ibid

and produced encyclopedic works which became standard texts and reference works for centuries. With the coming of the European Renaissance, they formed the basis on which European authors gained insight into the medicine of the 'Ancients' or early Greek authors whose works were only preserved in Arabic. In addition many rediscoveries took place which had already been recorded by the Islamic physicians but hitherto had been unknown until recently uncovered[45].

The classical example of the discovery of pulmonary circulation originally given to Servetus was found to have been succinctly described by Ibn Tofayl, Ibn Rushd and Ibn Nafis Islamic physicians who lived centuries earlier. Ibn Nafis repudiated the earlier concepts held by Galen and described the lesser circulation so succintly that nothing more could be added until Malphigi could describe the alveoli and the pulmonary capillaries with the advent of the microscope discovered by Anthony Von Luwenheek in mid-19th century. Some of them form the basis of instruction of students of *Tibb* and *Hikma* the traditional Islamic medicine practiced in the subcontinent of India and Pakistan, even today under the banner of Tibb or Unani medicine[46].

The historic periods of the Islamic physicians can be divided into three parts: 1.The period of Islamic Renaissance: From the beginning of Islam to the end of the Abbasid dynasty. 2. The period of Islamic epoch: When all sciences including medicine reached the pinnacle of development under Islamic patronage. 3. The period of decline: during which the knowledge of Islamic medicine was translated into European languages and became the basis of further development and discoveries and ultimately led to basis for the development of Modern medicine[47].

[45]Nagamia, (2003)
[46]Ibid
[47]Ibid

1. The Period of Islamic Renaissance

The notable physicians during this period were as follows:

1. Bukhtishu family of physicians. The oldest amongst these was Jibrail Bukhtishu who was the Chief physician at the Hospital in Jundishapur. He came from a Christian family and was summoned to the court of Caliph Mamun (148AH/765 AD) when the latter fell ill. After having treated him succesfuly he was invited to stay in Baghdad and head a hospital there but he declined and returned to his native Jundishapur (152 AH/769 AD) It was his son Jurjis Bukhtishu who was later invited by Caliph Harun-ul-Rashid to come to Baghdad to treat him (171AH/787 AD) and then offered to be the Chief physician and head a hospital in Baghdad which he did till he died in 185 AH/801 AD)[48].
2. Masawaih is another family of physicians associated with early Islamic History. During the reign of Caliph Harun-ul-Rashid the elder of the family migrated from Jundishapur to Baghdad and become a celebrated Ophthalmologist. He wrote the first Arabic treatise on ophthalmology. His son known to the west as Mesue Senior with real name of Yuhanna ibn Masawayh wrote several medical works in Arabic while translating other works from Greek. He is known for somewhat of a sarcastic temperament but, none the less, commanded great respect because of his medical expertise.
3. Hunayn ibn Ishaq who was a student of Ibn Masawayh became the greatest translator of Greek and Syriac medical texts during the 3rd century AH/9th century AD. He was responsible for masterly translations of Galen, Hippocrates, and Aristotle into Arabic. He also improved the Arabic medical lexicon giving it a rich technical medical language to express medical terminology and thus laid the foundations of the rich medical expression in Arabic language far excelling

[48] Nagamia, (2003)

later translations from Arabic to Latin. He was himself an astute physician and wrote two original works on ophthalmology[49].

4. Ali ibn Rabban al-Tabbari has the credit of the first systematic work on medicine during this era. He hailed from Persia but settled in Baghdad in the first half of the 3rd century AH/9th century AD. His work called '*Firdaws a—Hikma*' or 'Paradise of Wisdom' contained extensive information from all extant sources including Greek, Syriac, Persian and Indian and contained an extensive treatment of Anatomy.

2. The Islamic Epoch

Al-Razi

The most famous and notable physician of this time and perhaps of the entire early Islamic era is no doubt Muhammad ibn Zakariyya al-Razi(born 251 AH/865 AD; died 312 AH/925 AD) called Rhazes by his Latinized name. Born in Rayy in northern Persia not much is known about his early life or his medical education. His fame starts with the establishment of a hospital in Baghdad of which he was the chief. The story of how he picked the site of the Hospital when asked to select one, has become one of the classical legends of Islamic medicine. He had pieces of meat hung in various quarters of the city and had them examined for putrefaction and then recommended the site where the meat had decayed the least as the most suitable site. He thus became the first physician to infer indirectly the bacteriologic putrefaction of meat, and suggesting the environmental role that contaminated air plays in the spread of infection, predating by centuries the modern concept of air borne infection. But besides this astute observation, Al-Razi is known for numerous other original contributions to the Art and Science of medicine[50].

[49] Nagamia, (2003)
[50] Ibid

Relatively speaking, the most important of al-Razi's minor treatises is *Kitab al-Judari w-al-Hasabah*. It deals with smallpox and measles. It was translated into Greek and Latin and printed in several European countries. This work is particularly significant because it is the first to give a clear description of smallpox as a disease and also the first to give a symptomatic distinction between smallpox and measles. Al-Razi described an allergy to roses in one of his classical cases. He was the first to include in the pharmacopoeia white-lead ointment, later on known in the Middle Ages in Europe as Album Rhases, and also the first to use mercury as a purgative. He was also the first to use "animal gut as a ligature for surgical operations and was the first to recognize the reaction of the pupil to light."[51]

The famous Islamic historian and scientist al-Biruni has listed 56 medical works of al-Razi the most famous being *al-Hawi* or the Continents which is an encyclopedia of medical knowledge based on his personal observations and experiences. A shorter medical text- book was dedicated to al-Mansur and hence called *Kitabal-Mansuri.*[52]

Besides these and other original contributions, of which most have all been published and some survive to this day al-Razi devoted a lot of his time to teaching, bedside medicine and attending to the royalty and court. The impact of these publications on Islamic medicine was tremendous. His books became an invaluable addition to the armamentarium of a medical student of the time and remained standard texts until the appearance much later of texts by al-Majusi and by Ibn-Sina: *'Qanun fil Tibb'* 'The Canon of medicine' of which a description will be given later[53].

[51]Sharif, (1963), *A History of Muslim Philosophy*, Alhassanain, Karachi, p558
[52]Nagamia, (2003)
[53]Ibid

Al-Majusi

In the 4th century of Hijra, 10th century AD another Islamic physician gained prominence in Baghdad. His name was al-Majusi or Haly Abbas to the west (d 384 AH/994 AD). He became the director of the Adud- Dawlah Hospital .It was to its founder that al-Majusi dedicated his medical work entitled '*Kitab Kamil al Fina al-Tibbiyah'* or ' The complete book of the medical Art ' also called '*al-Kitab al-Maliki'* or 'The Royal Book'. This book is very well systematized and organized. Divided into two basic volumes one covers theory and the other practical aspects. Each of these has 10 chapters. The first volume deals with historical sources, anatomy, faculties, six primeval functions, classification and causation of disease, symptoms and diagnosis, urine, sputum, saliva and pulse as an aid to diagnosis, external or visible manifestations of disease and internal diseases like fever, headache, epilepsy and warning signs of death or recovery. The second volume deals with hygiene, diets, and cosmetics. Therapy with simple drugs, therapy for fevers and diseases of organs, digestion, reproduction etc. There is a chapter on surgery, orthopedics, and finally treatment by compound medicaments[54].

Most important parts of it relate to dietetics and *materia medica*. He made some original clinical observations and was the first to give a close description of the capillary circulation long before Harvey. He says that during relaxation (diastole) the pulsating vessels (arteries) that are near the heart draw air and thinned blood from the heart by suction, because during their contraction (systole) the arteries empty themselves of blood and air, so that when they relax, air and blood is sucked to them to fill them. Those that are near the skin draw air from outside. Those that are in the middle, between the heart and the skin, have the property of drawing the thinnest blood from the non-pulsating vessels (veins).[55]

[54] Nagamia, (2003)
[55] Sharif, (1963), p559

That is because the veins have pores communicating with the arteries. The proof of this is that if an artery is cut, all the blood that is in the vein is emptied through the cut. He was also the first to give proof of the motion of the womb during parturition and to show that child does not come out by itself, but it is the movement of the womb that pushes it out. In al-Qifti's words *al-Maliki* was the splendid work and the noble treasure of the theory and practice of medicine admirably arranged. It had been one of the most popular texts on medicine until it was replaced by ibn Sina's *Qanun*[56].

Al-Majusi gives a remarkably well-worded advice to physicians. He says that the patient should be treated if possible with diet, not with drugs. If he can be treated with simple drugs he should not be administered compound ones, nor indeed strange or unknown ones. With regard to the relation between the physician, the patient, and the disease, he says that they are three. If the patient co-operates with the physician they would become two against one and would be able to beat the disease, but if he does not listen to the physician nor follow his direction, he and the disease would be two against one, i.e., the physician; one can hardly beat two. He states that all physicians agree that the preservation of health is more important than the cure of disease and quotes Hippocrates that the curing force of disease is nature itself[57].

Al-Majusi's surgical technique is no less remarkable. His lucid description of the surgical operation for the removal of tubercular glands is a fine specimen of his art. He says: "*Cut the skin longitudinally down to the gland. Retract the skin with hooks. Dissect slowly and gently, freeing the gland from the tissues around it. Take care not to cut any vessel or puncture any nerve. If a vessel is cut, ligate it, lest the hemorrhage obscure the field and prevent you from carrying out a proper and thorough operation.*" After removal of the gland, put your finger in to feel for any small glands that might be left. If there are any, remove them too. When all the glands are removed, suture the incision[58].

[56]Sharif, (1963), p559-560
[57]Ibid
[58]Ibid

Al-Majusi recognized the gravity of cancer and says that medicines do not help in curing the disease. He advises removal of the whole area affected by cutting at a distance from the growth so that none of its roots are left. He advises that after removal blood should not be stopped from running but that the surgeon should see that the diseased blood is drained off[59]

Al-Zahrawi

About the 2nd century AH/ 8th century AD a great center of knowledge learning and culture had been developing in the western part of the Islamic empire. This was in Spain or 'Andalusia' as it was called by the Arabs. Spain had been invaded and conquered by the Muslims in 93 AH/714 AD. When the Ummayad dynasty ended in Damascus, the last of Ummayad princes had escaped to Spain where he established a great dynasty called the Western Caliphate. The rulers of this dynasty laid the foundation of Muslim rule in Spain that was to last for seven centuries. The apogee of this period was to come during the reign of Amir Abd ar-Rahman Al-Dakhil in 138 AH/756 AD. During his reign Cordoba also called '*Qurtuba'* became a great center of International learning. A great library containing more than a million volumes was established. Sciences flourished and great men of learning and physicians worked under the Royal patronage. Later this center was to shift to Granada, under the patronage of the great Ummayad ruler Abd al-Rahman III al-Nasir (300-350 AH/912-961 AD). Perhaps the most famous physician and surgeon of the era was 'Abu al-Qasim Khalaf ibn al-Abbas Al-Zahrawi' known to the west as Albucasis (318 AH/930 AD to 403 AH/1013 AD). He gained great fame as a physician. He wrote a major compendium of extant medical knowledge called '*Tasrif* '. It comprised thirty volumes. The initial volumes dealt with general principles,

[59]Sharif, (1963)

elements and physiology of humors and the rest deal with systematic treatment of diseases from head to foot. One of the topics discussed in this work is the preparation of medicines by sublimation and distillation. It's most important part is, however, surgical wherein he introduces and emphasizes such new ideas as cauterization of wounds, crushing stone inside the bladder, and the necessity of vivisection and dissection. He also deals with obstetrics and the surgery of eyes, ears, and teeth and gives a description of surgical instruments[60].

It was the first textbook of Surgery with illustrations of instruments used in Surgery to be ever published. It gained such great fame that it became the standard textbook of surgery in prestigious universities in the west and was most widely read. He emphasized that knowledge of Anatomy and physiology was essential prior to undertaking any surgery: '*Before practicing surgery one should gain knowledge of anatomy and the function of organs so that he will understand their shape, connections and borders. He should become thoroughly familiar with nerves muscles bones arteries and veins. If one does not comprehend the anatomy and physiology one can commit a mistake which will result in the death of the patient. I have seen someone incise into a swelling in the neck thinking it was an abscess, when it was an aneurysm and the patient dying on the spot*.' Some operations described by him are carried out even today in the manner he described them almost 1000 years ago! These would include operations on varicose veins, reduction of skull fractures, dental extractions, forceps delivery for a dead fetus to mention just a few. Surgery was raised to a high level of science by him, at a time when the council of Tours in Europe declared in 1163 AD: '*Surgery is to be abandoned by all schools of medicine and by all decent physicians*'[61]

[60]Nagamia, (2003)
[61]Ibid

The surgical part of al-Tasrif was translated into Latin by Gerard of Cremona, and various editions of it were published at Venice, Basel, and Oxford from the ninth/fifteenth to the twelfth/eighteenth century. For centuries it was used as a text-book in surgery in the universities of Europe such as Salerno, Montpellier, and other schools of medicine[62].

Ibn Sina

One of the greatest physician of the Islamic era was Avicenna or Ibn-Sina his full name being: 'Abu Ali al-Husayn ibn Abdallah ibn Sina'. Some historians of medicine acclaim him to be the greatest physician that has ever lived. That is because Ibn-Sina was not only a physician par excellence but his knowledge and wisdom extended to many other branches of science and culture including philosophy, metaphysics, logic, and religion. As a result of his great wisdom, he has been awarded the titles: *al-Shaykh al- Rais* (The chief master) and *al-Muallim al-Thani* (the second philosopher after Aristotle)[63].

Ibn-Sina was indeed a prodigy. At the age of 10 he had memorized the whole Quran. By the age of 16 he had mastered all extant sciences that appealed to him including mathematics, geometry, Islamic law, logic, philosophy and metaphysics. By age 18 he taught himself all that was to learn in medicine. Born in city of Bukhara in what is now central Asia in the year 370 AH/980 AD he rapidly rose in ranks and became the vizier (prime minister) and court physician of the Samanid ruler of Bukhara prince Nuh ibn-Mansur, after he cured him at the age of only eighteen. The Royal Library was opened to him and this enlarged the knowledge of Avicenna to new dimensions. He began writing his first book at age 21. In all, in the short span of 30 years of writing this man had written over a 100 books of which 16 were on medicine. His magnum opus is one of the classics of medicine ever written. The Canon of medicine as it became known in the west was written with the title of '*Kitab al-Qanun*

[62]Nagamia, (2003)
[63]Ibid

fi al- Tibb'. Used as "medical Bible" for a longer period than any other book,"[34] an encyclopedic work of about a million words covering the entire medical knowledge, ancient as well as contemporary. In many ways he resembled Galen. Before ibn Sina's *Qanun*, the best work on medicine was al-Razi's *al-Hawi* but, according to all competent authorities, that work was superseded by the *Qanun*. Ibn Sina analysed for the first time pathological and psychological phenomena and made acute observations about the differential diagnosis of mediastinitis and pleurisy, infectious nature of phthisis, skin diseases, sexual ailments and perversions (including love-sickness), diseases of the nervous system, and transmission of diseases through water, food, and soil. It was composed of five volumes: Volume I contained the general principles Volume II Simple drugs Volume III systematic description of diseases from head to foot Volume IV general maladies and fevers and Volume V Compound drugs[64].

Ibn Sina is the first to write a careful description of meningitis and differentiate between primary and secondary meningismus. He also gives a full description of the various types of diseases which cause jaundice. He differentiates between facial paralysis of central origin and that of local origin. He describes apoplexy as being caused by plethora. He gives a clear description of the symptoms of pleurisy and its differential diagnosis. The signs of pleurisy, he says, are: continuous fever; stitch in the side which many times does not appear except after a deep breath; shortness of breath; see-saw pulse; and cough, usually dry in the beginning, but may be wet and with expectoration from the start. He says: In as much as pleurisy might resemble hepatitis and pneumonia, we must differentiate between them. The difference between pleurisy and hepatitis is that in the latter the pulse is wavy, the pain is dull and heavy and not pricking, the face is yellowish, the urine thick and the stools "livery." There is heaviness in the right side over the liver region and no stitch in the side. The

[64]Nagamia, (2003)

difference between pleurisy and pneumonia is that in the latter the pulse is wavy, the shortness of breath more marked, the breath hotter besides other symptoms.[65]

Several commentaries on the *Qanun* are extant, the best known being by ibn Nafis under the title al-Mu'jiz. In the Asian part of the Muslim world, the *Qanun* held the sway, but in Spain it was played down by ibn Zuhr (d.1160) and ibn Rushd (d.1198).

In Europe, the Canon was translated into Latin by Gerard of Cremona[66] and Andrea Alpago and remained the standard textbook of medicine in Louvain and Montpellier until the 17th Century. The effects of the systematic collection of hitherto unorganized Greco-Roman medicine and adding to it by personal observation and experimentation of these physician brought medicine to a new pinnacles of practice[67].

Another unique book by ibn Sina is the *Urjuzah fi al-Tibb*, which is a medical poem that sums up the medical knowledge of the time. It was meant to facilitate the study of medicine. With their wonderfully tenacious memories the Arabs were able to memorize it. Its first part deals with the theory of medicine and hygiene, and the second with treatment. Another of his wellknown books is *al-Shifa'*. Usaibi'ah credits him with having written nineteen medical and ninety non-medical books[68].

The illustrious "Shaikh," by which name ibn Sina is generally known throughout the Muslim world, died at Hamdin in 428/1037. He reigned supreme for more than six centuries not only in the Eastern Muslim world but also in Christendom. His theories, as propounded in the *Qanun*, are still widely respected in the Orient by Hakims and form the cornerstone of the history of medical teaching in the Occident (Europe)[69].

[65]Sharif, (1963), p560
[66]Ibid, p561
[67]Nagamia, (2003)
[68]Sharif, (1963), p561
[69]Ibid

Ibn al-Haitham

In Egypt flourished ibn al-Haitham (Alhazen of the West), "the greatest Muslim physicist and one of the greatest students of optics of all times." Abu Ali al Hasan Ibn al-Haytham, (ca. 965-1040 CE) was born in Basrah but migrated to Egypt in the time of Caliph al-Hakim. "He was also an astronomer, mathematician, physician, and he wrote commentaries on Galen and Aristotle." He corrected the Greek misconception about the nature of vision and taught, for the first time, that light does not "exude" from the eye but enters it. He also taught that the retina was the seat of vision and that the impressions made upon it were conveyed along the optic nerve to the brain forming visual images on symmetrical portions of both retinas[70].

He will later be recognized as one of the greatest scientists known in Islamic history. Alhazen's empirical method revolutionized scientific thinking/way to seek knowledge of his time and went on to influence the advancements of later science including that of seventeenth century Christian Europe[71].

Ibn Zuhr

In Spain there was a most famous family of physicians whose contribution to medicine was no less remarkable. Translations from the works of this family are found in the libraries of Western universities even to the present day. We are referring to the ibn Zuhr family that drew its name from their ancestor Zuhr. The first great physician of the family was abu Marwan 'Abd al-Malik (d. 470/1077-78). He was renowned as a diagnostician. His son abu al-'Ala' (d. 525/1130-31) was even a greater physician than him. He was first attached to the Court of Seville but was later raised to the rank

[70]Sharif, (1963), p561

[71]Rathburn, (2016), "Alhazen's Method of Empiricism and its Contributions to Advancing Science", IRL/*http://humanstudy.org/2016/12/25/alhazens-method-of-empiricism-and-its-contributions-to-advancing-science/*consulted in June 2020.

of a vizier when that kingdom was conquered by Yusuf ibn Tashifin. He wrote several medical works, viz., *Kitab al-Khwass* (Book of Properties), *Kitab al-Adwiyah al-Mufradah* (Book of Simple Drugs), *Kitab al-Idah* (Book of Explanation), *Mujarrabat* (Personally Tested Prescriptions), *Kitab Hall Sukuk al-Razi 'ala Kutub Jalinus* (Resolution of al-Razi's Doubts regarding Galen's Works), *Kitab al-Nukat al-Tibbiyyah* (Book on Principles of Medicine). The last mentioned work among other things specially deals with climatological and anthropological conditions prevailing in Marrakesh and with deontological guidance. He also wrote a treatise in refutation of certain points in ibn Sina's work on simple drugs[72].

The most illustrious member of this family was abu Marwan 'Abd al-Malik ibn abi al-'Ala' Zuhr (d. 556-557/1160-1161) known in Latin works as Avenzor. His supremacy as a physician was acknowledged not only in the Muslim world but also in Christendom. His medical theory had strong empirical tendencies. He may justly be said to be the greatest clinician of Islam after al-Razi. Only three of his at least six works are now extant.

1. *Kitab al-Taisir fi al-Muddwat w-al-Tadbir* (Book of Simplification on Therapeutics and Diet), written at the request of ibn Rushd, is the most important of them all. It deals elaborately with pathology and therapeutics and at the end gives a comprehensive collection of recipes. In this work ibn Zuhr makes acute clinical observations about mediastinal tumours, intestinal phthisis, pericarditis, scabies, pharyngeal paralysis, and inflammation of the middle ear.

2. *Kitab al-Aghdhiyah* (Book on Diet).

3. *Kitab al-Iqtisad* dealing with therapeutics, psychotherapy, and hygiene.

72 Sharif, (1963), p562

Ibn Zuhr's son abu Bakr Muhammad ibn al-Malik was a successful physician and his daughter and his grand-daughter were capable midwives. Medicine went into the family down to six generations. Ibn Zuhr's influence upon Western medicine, through Hebrew and Latin translations, lasted till the end of the eleventh/seventeenth century. The translations of *Taisir* like ibn Rushd's *Kulliyat* saw several editions[73].

Ibn Rushd

The great Spanish philosopher ibn Rushd (Averroes) was a contemporary of ibn Zuhr. His greatness as a physician was eclipsed only by his greatness as a philosopher. His most important medical work *Kitab al-Kulliyat fi al-Tibb* (Latin 'Colliget') was a veritable encyclopedia of medicine. As mentioned above, the Latin translation of this work went through several editions in Europe. It was also translated twice in Hebrew. It had seven parts (books) dealing with anatomy, physiology, pathology, diagnostics, materia medica, hygiene, and therapeutics. He was the first to discover that no person can get smallpox more than once. He is also said to be the first to understand the working of the retina[74].

Ibn Tufail, ibn Rushd's predecessor in philosophy, was also a renowned physician; he wrote two books on medicine, neither of which is extant.

Ibn Baitar

Another name worth mentioning in connection with the development of medicine in the Muslim West is that of ibn Baitar. He was born in Malaga and travelled all over Spain, North Africa, Egypt, Syria, and Asia Minor. He was a botanist rather than a pharmacologist. Most of his work was done in Egypt where he was appointed chief inspector of pharmacies. His two chief works, *al-Mughni fi al-Adwiyah al-Mufradah* and *al-Jami' li Mufradat al-Adwiyah w-al-Aqhdiyah*, embodied all the Greek and

[73] Sharif, (1963), p562-563
[74] Ibid

Arabic literature on botany and materia medica as well as the author's own wide experience and research. He describes more than one thousand and four hundred drugs from the vegetable, animal, and mineral kingdoms, three hundred of which are novelties. The book is arranged alphabetically. Usaibi`ah describes the thoroughness of his teacher's methods; Usaibi`ah was not only al-Baitar's pupil but also herborized with him in Syria. His book *al-Adwiyah al-Mufradah* was translated into Latin, 'Simplicibus', printed in twenty-six editions during and after the ninth/fifteenth century, and was used in the formation of the first London pharmacopoeia issued by the College of Physicians during the reign of James I. Some parts of its Latin version were printed as late as 1172/1758 at Cremona[75].

Ibn al-Nafis

`Ala' al-Din abu al-Hasan `Ali ibn abi al-Hazm, better known as ibn alNafis, flourished during the first half of the seventh/thirteenth century. Born in Damascus, he spent most of his life in Cairo where he practised medicine and became dean of the Mansuri hospital. He wrote several books, the most important being *al-Mu'jiz* and *Sharh Tashrih al-Qanun*. In describing the anatomy of the pulmonary vessels, ibn Nafis also described for the first time the pulmonary circulation and declared three centuries before Servetus that blood is aerated in the lungs. In his description of the anatomy of the heart he gives the nearest description in those times of the coronary circulation. He says that ibn Sina's statement that the blood which is in the right side of the heart is to nourish the heart is not true at all, because the nourishment of the heart is from the blood that goes into the vessels that permeate the body of the heart.

Arab bibliographers, like al-Qifti, ibn abi Usaibi`ah, and ibn Khallikan, have done a magnificent job in collecting the works of various authors. However, it is a fact

[75]Sharif, (1963), p563

that scores and scores of manuscripts are still lying unexplored in libraries and mosques, palaces and museums and are awaiting careful examination; these may open fresh sluice-gates of knowledge regarding the Muslim contribution to medical and other sciences[76].

III- Medical Institutions

1. Hospitals

The idea of a hospital as an institutional place for the caring of the sick has not been recorded in antiquity. There were sanatoria and 'travel lodges' that were attached to temples where the sick were attended to by attendant priests. Most of the therapy in these sanatoria consisted of prayers and sacrifices to the gods of healing especially to Aesculapius. Cures that occurred were thought to result from divine interventions.

A large number of hospitals were developed early during the Islamic era. They were called '*Bimaristan'* or '*Maristan'*[77].

The bimaristans were of two types; mobile and fixed. The mobile bimaristan dates back to the time of the Prophet Muhammad. During the Ghazwah Khandaq (the Battle of the Ditch), a separate tent was erected for the wounded. Over time, Caliphs and rulers developed and extended these units into true travelling dispensaries with doctors and pharmacists. These bimaristans were transported upon beasts of burden. The physicians in the mobile clinics were of the same standing as those in fixed hospitals, and the field hospitals were well equipped with medicaments, instruments, tents, and a staff of doctors, nurses and orderlies. These mobile bimaristans allowed state services to reach the disabled, the disadvantaged, and those in remote areas. By

[76]Sharif, (1963)
[77]Nagamia, (2003)

the reign of the Seljuq Turkish Sultan Muhammad Saljuqi, the mobile bimaristan had become so extensive that its equipment needed forty camels to transport it. There is some controversy as to the events surrounding the construction of the first permanent Islamic bimaristan. Many credit the Ummayad Caliph Al-Walid bin Abdel Malik with building the first permanent bimaristan in Damascus in 707 AD (88 AH).6,9 This bimaristan treated chronically ill patients such as lepers and blind people. However, some consider it no more than a leprosaria, as it permitted the quarantine of patients with leprosy from others. There were salaried physicians on staff at all times, and the leprosy patients were treated gratis and granted a monetary stipend upon discharge[78].

The first agreed permanent Muslim-patroned bimaristan was built during the reign of Caliph Harun Al-Rashid (786- 809 AD [170-193 AH]). The Caliph invited the son of the chief physician, Jibrail Bukhtyishu, to come to Baghdad and head the new bimaristan. It rapidly achieved fame, resulting in the construction of others. Those chosen to oversee the construction of a new bimaristan were diligent to choose the best locations with regard to health conditions. They preferred to erect bimaristans atop hills or along rivers. For example, the Al-Adudi Hospital was built near Baghdad's Dejlah River in 981 AD. The river flowed through its courtyard and halls and returned to pour into the Dejlah. When Caliph Al-Muktafi asked Mohammed ibn Zakariyya Al-Razi (Rhazes) to build Baghdad General Hospital, Al-Razi had pieces of meat hung in various quarters of the city, observed their putrefaction, and advised the Caliph to site the bimaristan where the putrefaction was the slowest and the least[79].

At its inception it had 24 physicians on staff including specialists categorized as physiologists, oculists, surgeons and bonesetters. When Djubair visited Baghdad in

[78]Miller,(2006), "Jundi-Shapur, Bimaristans, and The Rise of Academic Medical Centers", *Journal of the Royal Society of Medicine*, Vol 99, pp 615-617
[79]Ibid

580 AH/ 1184 AD he recorded that this hospital was ‘like a great castle’, with a water supply from the Tigris and all the appurtenances of Royal palaces[80].

One of the largest hospitals ever built was the Mansuri Hospital in Cairo it was completed in 1248 by the orders of the Mameluke ruler of Egypt, Mansur Qalaun. It was most elaborate. It had a total capacity of 8000 people, and served as a prototype for subsequent bimaristans. The annual income from endowments alone was one million dirhams. Men and women were admitted to separate wards. Irrespective of race religion and creed or citizenship (as specifically stated in the Waqf documents) nobody was ever turned away. There was no limit to the time the patient was treated as an inpatient, thus the patient could stay until he was fully recovered[81]. Patients who were cured of their maladies but still too weak for discharge were transferred to the convalescent ward until they were healthy enough to leave. Men and women occupied separate but equally equipped wards and were attended by nurses and orderlies of the same sex. There were separate wards for medicine, surgery, fever, wounds, mania, and eye diseases. Each hospital was equipped with its own pharmacy, library, lecture halls, mosque and occasionally a chapel for Christian patients. Musicians were employed to comfort and cheer patients via music therapy[82].

The Waqf document specially stated: ‘*The hospital shall keep all patients, men and women until they are completely recovered. All costs are to be borne by the hospital whether the people come from afar or near, whether they are residents or foreigners, strong or weak, low or high, rich or poor, employed or unemployed, blind or signed, physically or mentally ill, learned or illiterate. There are no conditions*

[80]Nagamia, (2003)
[81]Ibid
[82]Miller, (2006)

of consideration and payment; none is objected to or even indirectly hinted at for non-payment. The entire service is through the magnificence of Allah, the generous one.'[83]

Upon admission, the patient's clothes and money were placed into trust. The patients received clean clothes and were freely given medication and food under physician supervision until they were cured. Upon discharge, the patient's possessions were returned to them and they were sent with clean clothes and a grant of money to compensate them for lost wages and aid them in establishing a new livelihood. Issa writes in his "*Histoire des bimaristans à l'époque Islamique*": "*The furniture, bedding, and clothing at the Mansuri hospital at Cairo, rivalled in their luxury and perfection those that adorned the palaces of the Caliphs and the princes. The nourishment consisted of flesh of fowl and mutton, and each patient was given the quantity of food that the state of his health permitted.*"

Bimaristans also pioneered the development of written medical records. It was the students' responsibility to keep records of the patients and their medical treatment. These admirably detailed records were compiled, edited by clinicians, and formatted in a way that became known as 'treatments based on repeated experience.'[84]

As to the physical conditions of these hospitals especially those established by princes, rulers and viziers it can be stated that some of these were luxurious and were actual palaces that had been converted to hospitals. Even contemporary Europe could not boast of a single hospital that came close to the facilities that were provided in these institutions. Some of them especially in Baghdad, Egypt and Syria had furnishings were similar to those in the palaces. Most of these being under the patronage of the viziers, sultans and caliphs were no doubt inspired by the Islamic

[83]Nagamia, (2003)
[84]Ibid

teaching of the welfare of the poor and needy. The Quran tells us: *'You shall not attend to virtue unless you spend for the welfare of the poor from the choicest part of your wealth'* (3,92) and again: '*O you who believe spend (for the poor) from the worthiest part of what you have earned and what your crop yields, and do not give away from its unworthy parts -such that you yourselves will not take until you examine the quality minutely- and know that Allah is not in your need and all praise belongs to Him.*' (2,267).[85]

As to the salaries of physicians here is some information from authentic sources. The annual income of Jibrail ibn Bakitshu who was the Chief of Staff at a Baghdad hospital during the reign of Mamun Ar-Rashid as recorded by his own secretary was 4.9 million dirhams. His son also a doctor lived in a house in Baghdad that was air-conditioned by ice in summer and heated by charcoal in winter. A resident by comparison who was supposed to be on duty for two days and two nights a week, was paid 300 dirhams a month.[86]

General hospitals were established not only at Baghdad, Damascus, and Cairo, but also at Mecca, Jerusalem, Aleppo, Harran, and several cities in Andalusia[87].

The conditions prevailing in hospitals in those days can best be described in the words of Usaibi`ah

"*Abu al-Hakam, the dean of the Nuri hospital of Damascus -built by Nur al-Din Zangi-, used to make the rounds of patients every morning, find out their condition and consider their affairs. With him were his assistants and orderlies and all that he wrote down as orders for the patients regarding medicine and diet were carried out on time and without delay. After finishing his rounds he used to go to the citadel and treat whoever was sick among the nobility and government officials. He would then*

[85]Nagamia, (2003)
[86]Ibid
[87]Sharif, (1963), pp556-557

come back to the hospital and sit in the large auditorium, read his books, and prepare his lectures. Nur al-Din had installed in the hospital a large library with a collection of books and manuscripts placed in bookcases in the main hall. Several physicians and students used to come and sit at his feet. He taught the students and discussed medical topics and interesting cases with the physicians."

Usaibi`ah continues:

"Patients were examined in an outside hall and those who did not need hospital treatment were given prescriptions which were prepared at the hospital pharmacy.Those who needed hospital treatment were registered and admitted. They were given a bath and made to put on clean hospital clothes, their own clothes being taken away and stored. They were kept at the hospital until completely cured. On their discharge from the hospital they were given a suit of clothes and some money to defray immediate and necessary expenses outside the hospital until they were able to work."[88]

Usaibi'ah proceeds:

"A pharmacy under a competent and registered pharmacist was attached to every large hospital. It was well stocked with syrups, all sorts of drugs and drug preparations, fancy porcelain, and rarities. Pharmacists were licensed and registered and in each large town an inspector kept constant watch over pharmaceutical preparations and chemical products.Attached to large hospitals were medical schools where students gathered in the main hall and reviewed their studies and copied medical manuscripts which were compared and corrected by the teachers. The teachers lectured to them from the books of Galen and later from al-Razi and al-Majusi until the advent of ibn Sina's Canon which eclipsed them all."[89]

[88]Sharif, (1963), p557
[89]Ibid

Several books were written on hospitals and hospital management. Unfortunately, most of them have been lost. A1-Razi wrote a book on *Sifat alBimaristan* and Zahid al-`Ulama' wrote *Kitab al-Bimaristan*[90].

It will be seen from a brief description of the conditions obtaining at the time in hospitals that in many respects they were better than those prevailing even today. The Arabs may not have been the first to build hospitals but they were certainly the first to improve upon them. They started to give regular instruction in hospitals and to have out-patient departments. They were the first to have regular inspection over the administration and finances of the hospitals, the first to examine and license physicians, and the first to have regular pharmacies attached to hospitals. They went further by examining and licensing a physician for the practice of a specialty. The interest of Muslims in building hospitals was not limited to the Arab period; it continued throughout the ages[91].

2. Licensing of Physicians

Another lasting advancement made during this time period was that of physician licensure. In 931 AD Caliph Al-Muctadir learned that a patient had died in Baghdad as a result of a physician's error. Consequently, he ordered Sinan ibn Thabit to examine all those who practiced the art of healing. Of the 860 medical practitioners he examined, 160 failed. From that time on, licensing examinations were required and administered in various places. Licensing boards were set up under a government official called *Muhtasib*, or inspector general. The chief physician gave oral and practical examinations, and if the young physician was successful, the *Muhtasib* administered the Hippocratic Oath and issued a license to practice medicine[92].

[90]Sharif, (1963), p557
[91]Ibid
[92]Miller, (2006)

Education in Islamic society was primarily religious, being devoted to the study of Islam and its ancillary sciences. From its origin in the mosque, Muslim higher education gradually became formalized and institutionalized; by the eleventh century A. D., formal education clearly focused on Islamic law and was centered in the *madrasah,* or endowed college. The "ancient" or Greek sciences, such as philosophy, medicine, and mathematics, were studied privately by jurists and theologians and their students, but unlike the Muslim sciences in the madrasah, they were not subsidized[93]. On this point, George Makdisi has written:

"Such a mixture of supposedly irreconcilable subjects would not have been possible in a system where there was no easy access .to the Ancient Sciences. Not only was access easy, it was in turn concealed, condoned, allowed, encouraged, held in honor, according to different regions and periods, in spite of the traditionalist opposition, the periodic prohibitions, and auto-date"[94].

The science of medicine, specifically, was a bridge between the Islamic and the "ancient" sciences, for it was often taught in the mosques and later in the *madrasahs* by the physician-jurist. The *madrasah*, however, was devoted primarily to the study of Islamic law; between the eleventh and twelfth centuries A.D., *madrasahs* that embraced both Muslim and foreign sciences became extinct. From the end of the twelfth century A. D., cognate institutions were established for the ancillary foreign sciences. This institutional specialization explains the exceptional development of madrasahs designated for the study of medicine, for medical education was usually conducted in private or in hospitals[95].

Many bimaristans also contained medical schools for resident and student education. The ablest physicians— such as Al-Razi (Rhazes), Ibn Sina (Avicenna) and

[93]Dols, Gamal, pp 25-26

[94]Makdisi, G. (1981),*The Rise of Colleges: Institutions of Learning in Islam and the West*, Edinbrugh, Edinburgh University Press, pp.75-77.

[95]Dols, Gamal, (1984), p 26

Ibn Zuhr (Avenzoar)—were hospital directors and deans of medical schools. Only Jundi-Shapur and Baghdad had separate schools for teaching the basic sciences. Otherwise, these were taught at the same facility as the clinical instruction. Basic science preparation consisted of lessons from private tutors, self-study and lectures. Anatomy was taught through lectures, illustrations and ape dissections. Students also studied medicinal herbs and pharmacognosy. The clinical training was accomplished by assigning small student groups to experienced instructors forward rounds, discussions, lectures and reviews. Therapeutics and pathology were taught early on. After a period of ward instruction, students were assigned to outpatient areas. The keeping of detailed medical records for every patient was the responsibility of the students[96].

The Islamic ideal of medical education was based on the medical curriculum of Alexandria. Its preparatory course included language and grammar, logic, arithmetic, geometry, the compounding of drugs, astrology, and ethics. The main course used four books on logic (the first four books of Aristotle's Organon) and twenty books on medicine: Hippocrates' Aphorisms, Prognostics, Regimen in Acute Diseases, and Airs, Waters and Places and the "Sixteen Books" of Galen. 138 Completion of this curriculum, particularly the "Sixteen Books," became the criterion for the accomplished physician. Arabic terminology is telling: the *tabib*, according to Ibn Ridiwan, was a doctor educated in the entire course of study, whereas the *mutatabbib* was one trained only in the preliminary course[97].

There were generally three methods of obtaining medical education in the Middle Ages. Sons and sometimes daughters were taught by their fathers; several generations of physicians was not uncommon. A physician could also be self-taught. Finally, and most important, medical education in a class, or privately with a tutor,

[96] Miller, (2006)
[97] Dols, Gamal, (1984), pp 28-30

took place in mosques, *madrasahs,* libraries, hospitals, or scholars' homes. Medical theory was usually taught in the traditional lesson-circle (Ar. *halqah)*[98].

The accomplished physician, like a lawyer, would have to recall passages from authoritative texts accurately and promptly[99]. The physician 'Abd al-Latif al-Baghdadi (d. A.D. 1231) was typical in his advice: "*When you read a book make every effort to learn it by heart and master its meaning. Imagine the book to have disappeared and that you can dispense with it, unaffected by its loss.*"[100]

The medical books, however, required exegesis by an instructor because of the difficult language and subject matter. "Teachers frequently dictated to their students their own works, or those of others, which were read back to verify their accuracy. Regular lectures were also given. The students took extensive notes which they often turned into handbooks. The scholastic method of argumentation was also used orally in class; this method of teaching is reflected in the organization of many medical works, such as Hunayn ibn Ishaq's early primer *Questions on Medicine for Scholars,* and numerous commentaries.

Because of the emphasis on books, which were quite expensive, access to libraries was essential for the well-trained student. Medical texts were available in a variety of places-hospitals, royal libraries, private collections, and from booksellers[101].

3. Libraries

The great intellectual activity that happened in the Muslim world brought its results, for gradually every large city developed a library which contained reading-rooms, quarters for translators, and meeting-places for scientific discussions. Such

[98]Dols, Gamal, (1984), pp 28-30
[99]Ibid
[100]Quoted in Makdisi, *The Rise of Colleges*, p. 103
[101]Dols, Gamal, (1984), pp 30-31

were Bait al-Hikmah (House of Wisdom) in Baghdad and Dar al-Hikmah (Hall of Wisdom) in Cairo. The library of Nuh ibn Mansur, ruler of Bukhara, contained books on all subjects together with their indices. Ibn al-Matron, the famous physician of Salah al-Din, had a library of 10,000 manuscripts. Ibn al-Tilmidh, author of the best known pharmacopoeia of his time, had 20,000 manuscripts in his library. The well-known medical historian al-Qifti had a library worth more than 50,000 dinars.[102]

Extensive libraries were attached to the hospitals, containing the most up-to-date books. In 872 AD, Tulum Hospital in Cairo had 100 000 books. Mustansiriyya University in Baghdad had 80 000 volumes, Cordoba library had 600 000 volumes, Cairo had 2 000 000 volumes and Tripoli had 3 000 000 volumes. Putting this last fact into perspective, in the 14th century Europe's largest library, at the University of Paris, consisted of a mere 400 volumes. The library at Tripoli was 7500 times the size of that in Paris![103]

The complex structure and hierarchy of Islamic hospitals, the advent of medical records, the introduction of physician licensure, and government oversight with universal access to care set the example upon which later hospitals were modelled. Much of the history of early western medicine was denigrated by the destruction of ancient libraries and the ethnic purging of near- and middle easterners from western medical history texts. It would be false to assert that western hospitals developed independently of their near-eastern predecessors, when Spain and Portugal (part of the Islamic empire for over 700 years) were riddled with bimaristans. Cordoba alone had fifty major hospitals and the Granada bimaristan served as the model for the Hospital Real in Santiago di Compostela and later Granada hospital, commissioned by Ferdinand and Isabella. Physicians fleeing Spain moved on to establish academic

[102]Sharif, (1963), p556
[103]Miller, (2006)

medical centers in other European cities such as Salerno. Additionally, upon returning from a crusade, the Knights of St John were called 'Hospitallers' due to the hospitals they constructed based upon the Arabic model founded by Saladin. Between the Andalusian hospitals, those in the lands of the Crusades and the bimaristans, where westerners were treated along trade routes and during travel expeditions, Westerners had extensive interactions with the bimaristans that were nearly 1000 years the predecessors of their western counterparts. They treated inpatients and had outpatient clinics. They travelled to prisons and treated the mentally ill. They cared for all who sought treatment and turned none away. Medical schools and resident physician training blossomed[104].

IV- Islamic Pharmacy

One of the greatest sciences that had a great impetus on Islamic medicine was the development of pharmacy and pharmacognosy. Chemistry or '*Alchemia'* had been studied by most Islamic physicians and scholars. This study was furthered by concomitant development of techniques to refine drugs, medications and extracts by the processes of distillation, sublimation, and crystallization. Druggists or *Attarin* became commonplace in Islamic lands and their proliferation ultimately required the institution of licensing of pharmacists and druggists[105].

Arabic pharmacy (*Saydanah*) as a profession and school of thought separate from medicine was recognized by the beginning of the ninth century. Baghdad, the center of learning at the time, saw a rapid expansion of the number of privately owned

[104] Miller, (2006)
[105] Nagamia, (2003)

pharmacy shops, a trend that quickly spread to the suburbs and then to other Muslim cities[106].

The pharmacists who managed these new shops were skilled in the apothecary's art and very knowledgeable in the compounding, storing, and preserving of drugs. State-sponsored hospitals also had their own dispensaries attached to manufacturing laboratories where syrups, electuaries, ointments, and other pharmaceutical preparations were prepared on a relatively large scale. The pharmacists and their shops were periodically inspected by a government appointed official *al-Muhtasib* and his aides. These state inspectors were responsible for assuring the accuracy of the weights and measures as well as the purity of the materials used to make the drugs. This served as means of assuring quality and safeguarding the public[107].

One of the contributors to Arabic pharmacy in the ninth century was the Nestorian physician, Yuhanna bin Masawayh (ca.777-857). A second generation pharmacist, Ibn Masawayh penned an early treatise on therapeutic plants, listing about thirty aromatics including their physical properties, methods of detecting adulteration, and their pharmacological effects. In his medical work, Ibn Masawayh recommended the use of well-known medicinal plants to build up a natural resistance to diseases. He urged physicians to prescribe one remedy for each disease, using empirical and analogous reasoning. He finally stated that the physician, who could cure by using only diet without drugs, was the most successful and skilled[108].

Another of Ibn Masawayh's books, *Al- Mushajjar al-Kabir,* is a tabulated medical encyclopedia on diseases and their treatment by drugs and diet. Other works

[106]Tschanz, (2003), "A Short History of Islamic Pharmacy", *Journal of Islamic Society for the History of Islamic Medicine*, Vol 1.
[107]Ibid
[108]Tschanz, (2003)

include small treatises such as one on barley water, explaining how to prepare it and its therapeutic uses; (in this case in dentifrices; and to ameliorate the effect of purgative drugs)[109].

A younger colleague of Ibn Masawayh was Abu Hasan 'Ali b. Sahl Rabban at-Tabari born in 808. At 30 years old, he was summoned to Samarra by al-Mu'tasim (833-842), where he served as a government officer and a physician. At-Tabari wrote several medical books, the most famous of which is his *Paradise of Wisdom*, completed in 850. In addition to discussions on diseases and their remedies, the work also includes several chapters on materia medica, cereals, diets, utilities and therapeutic uses of animal and bird organs, as well as drugs and methods of their preparation. At-Tabari urged that the therapeutic value of each drug be reconciled with the particular disease, urging physicians not to fall prey to the routine remedy[110].

The first medical formulary to be written in Arabic was prepared by al-Aqrabadhin Sabur bin Sahl (d.869). The book included medical recipes stating the methods and techniques of compounding these remedies, their pharmacological actions, the dosages given of each, and the means of administration. The formulas are organized by the type of preparation to which they belong - i.e. tablets, powders, ointments, electuaries or syrups. Sabur's formulary-type compendium is unique in its organization and purposely written as a guidebook for pharmacists, whether in for use in their own private drugstores or in hospital pharmacies. As such it is the first true medical formulary ever created[111].

A few books related to pharmacy were written by the famous scholar Ya'qub bin Ishaq al-Kindi (d. 874). His contributions to philosophy, mathematics and astrology, however, were greater than those on medicine and therapy. He was an

[109] Tschanz, (2003)
[110] Ibid
[111] Ibid

outspoken critic of alchemists and attacked their procedures and claims as deceptive under the circumstances, insisting upon licensure and training of pharmacists[112].

Hunayn bin Ishaq's *Ten Treatises on the Eye* was completed in 860. It deserves mention because while the first nine treatises dealt with the diseases of the eye, the tenth was devoted to compounding drugs for eye medication. Hunayn, whose translations were literally worth their weight in gold, corrected the translation into Arabic of the major part of Dioscorides', *Materia Medica*, undertaken by his associate Istifan bin Basil (in the mid ninth century). As a result several books of materia medica were written in Arabic[113].

1. Recognition

The large hospitals, such as Adud al-Daulah, employed very large technical and administrative staff. The hospital was run by a non-medical administrator. He was assisted by a Chief Medical Officer (*Mutwalli* or dean) who was a physician. The other member of the hospitals troika was the *Shaikh Saydalani* who served as Chief Chemist and overseer of the dispensary. The post of Inspector-General of Hospitals was created during the Abbasid regime, which was usually occupied by the most outstanding physician of the Islamic world. The post of Chief Chemist was created, to head the Department which supervised the preparation of drugs. One of the most famous holders of the position was Ibn Baytar, the great botanist and herbalist who occupied this post in 1266[114].

[112] Tschanz, (2003)
[113] Ibid
[114] Ibid

2. Development of Pharmaceutical Literature

The earliest Islamic works on pharmacognosy were written before translation of the Greek works of Dioscorides. Titles such as *'Treatise on the power of drugs their beneficial and their ill effects'* and then again *The Power of simple drugs'* were written in the ninth century AD. From the Ninth Century onwards, the preparation and use of medicinal drugs had its own specialized literature. Pharmacological drugs were classified into simple and compound drugs, *'the mufraddat and the murakkabat'.* The effects of these were detailed and documented in the literature with a high degree of accuracy and completeness.[115]

Numerous Arabic and Persian treatises were subsequently written on medicaments. Medical encyclopedias usually had one chapter on materia medica and another on recipes for compound remedies - for example, Razi's *al-Hawi* mentions 829 drugs. Formularies were often composed as larger independent collections of recipes, and some were written for specific use in hospitals[116].

Al Razi was a Hakim, an alchemist and a philosopher. His book *Al-Hawi* was the largest medical encyclopedia composed by then. It contained on each medical subject all important information that was available from Greek and Arab sources, and this was concluded by him by giving his own remarks based on his experience and views. A special feature of his medical system was that he greatly favored cure through correct and regulated food. This was combined with his emphasis on the influence of psychological factors on health. He also tried proposed remedies first on animals in order to evaluate in their effects and side effects. He was also an expert surgeon and was the first to use opium for anesthesia[117].

[115] Tschanz, (2003)
[116] Ibid
[117] Al-Ghazal,(2003), "The Valuable Contributions of al-Razi (Rhazes) in the History of Pharmacy During the Middle Ages", *JISHIM*, Vol 2, Erdemir and Kaadan (Ed), Istanbul, Nobel Tip Kitabevleri.

The best survey of al-Razi's works from the medieval period seems to be an epistle by al-Biruni written about 1037. Through this epistle, can be seen concealed sides of al-Razi's life and his contributions as a prolific author and compiler to pharmacy and medical therapy. To understand and appreciate him fully, however, one should look upon him as the product and in the context of his time. For in the West and Byzantium this was "an age of faith", important to our discussion here, therefore, is his courageous attack of errors in the medical and philosophical teachings of the ancients. It was al-Razi who wrote a book, *Chukuk 'ala Nazariyyat jalinus*, in which he doubted the accuracy in many medical, physiological and therapeutic concepts, theories, and procedures as stated by Galen and which were blindly accepted and transmitted by his followers and later compilers and commentators[118].

On the professional level, al-Razi introduced many useful, progressive, medical and psychological ideas. He also attacked charlatans and fake doctors who roamed the cities and the countryside selling their nostrums and 'cures'. At the same time, he warned that even highly educated doctors did not have the answers for all medical problems and could not cure all sicknesses or heal every disease. Al-Razi exhorted practitioners to keep up with advanced knowledge by continually studying medical books and expose themselves to new information. He further classified diseases into three categories: those which are curable; those that can be cured; and those which are incurable. On the latter, he cited advanced cases of cancer and leprosy which if not cured, the doctor should not take blame[119].

Al-Razi was the first in Islam to write a book based on home medical remedies entitled *Man la Yahduruhu Teb* for the general public. He dedicated it to the poor, the travelers, and the ordinary citizens that could consult it for treatment of common

[118] Al-Ghazal,(2003)
[119] Ibid

ailments when the doctor was not available. This book, of course, is of special interest to the history of pharmacy, since books on the same theme continued to appear and find acceptance by readers up to the present century. In its 36 chapters, al-Razi described diets and drugs that can be found practically everywhere in apothecary's shops, the market place, in well-equipped kitchens, and in military camps. Thus, any intelligent mature person can follow its instructions and prepare the right recipes for good results. Some of the illnesses treated are headaches, colds, coughing, melancholy, and diseases of the eye, ear, and stomach[120].

In his other book on diets, their uses and disadvantages, *Manafi' al-Aghdiyyah*, al-Razi followed a pattern that had been introduced earlier by Galen. In it, al-Razi attempted to correct several errors made by Galen and to introduce new data missed by the latter. *Manafi'al- Aghdiyyah* is of great interest not only to pharmacy and medicine but to the history of the culinary art as well. Emphasizing specific matters and general regulations for healthy living, al-Razi discussed breads, waters, dairy products, fruits, vegetables, spices, meats, and fishes. He explained in detail their kinds, methods of preparation, physical properties, and therapeutic modes of action, and pointed out when they were useful and when not. He described the disadvantages of frequent consumption of wines leading to alcoholism, '*which often causes many serious diseases as epilepsy, paralysis, senile tremor in older people, cirrhosis, hepatitis, mental disorders, visionary distortions, obesity, debility, and impotence*'[121].

Al-Razi's last and largest medical encyclopedia is his *al-Hawi fit-Tibb*, which embraces all areas of medical knowledge of the time. It included sections related to 'pharmacy in the healing art', materials arranged in alphabetical order,

[120]Al-Ghazal,(2003)
[121]Ibid

compounded drugs, pharmaceutical dosage forms and toxicology. It also included numerous medical recipes and tested prescriptions that influenced 'medical therapy' in Islam and in the West during the Middle Ages. In his use of mineral drugs as external and internal remedies, including vitriol, copper, mercuric and arsenic salts, sal ammoniac, gold scoria, chalk, clay (as in the terra sigillata and Armenian clay), coral, pearl, tar, and bitumen, al-Razi, encouraged and pioneered chemotherapy in Islamic medicine[122].

3. Pharmacy as a Profession

Materia medica and texts containing compendia of drugs their effects appears frequently during the era of Islamic medicine. Notable amongst these is the contibution of Abu Bakr ibn Samghun of Cordoba on *'The Comprehensive book on views of the Ancients as well as the Moderns on Simple Drugs'* Ibn Juljul made a commentary of drugs and plants described by Dioscorides and added a number of newer ones. Al-Zahrawi's *Tasrif* had a section on plants and drugs. The second book of the Canon is devoted to the discussion of simple drugs and the powers and qualities being listed in charts. One of the most authoritative book on drugs was written by famous scholar and philosopher al-Biruni entitled '*The Book on drugs'* which contains a huge compendium of drugs, their actions and their equivalent names in several languages[123].

With all this information circulating it is not surprising that the Islamic s*aydalani* introduce a number of new substances and techniques including senna, camphor, sandalwood, musk, myrrh, cassia, tamarind, nutmeg, cloves, aconite, ambergris and mercury. They further introduced hemp & henbane as anesthetics, and established

[122] Al-Ghazal,(2003)
[123] Nagamia, (2003)

the monopoly on a dispensation of ointments, pills, elixirs, confections, tinctures, suppositories and inhalants[124].

As was the case in Europe and America up to modern times, many prominent physicians in Islam, prepared the necessary medications for their patients. Al-Majusi, al-Zahrawi, and Ibn Sina are good examples. But this was the exception for the extremely gifted. For the typical medical professional, the role of educated pharmacists in the medical field and in society could not be ignored and was, in fact, welcomed. As part of the health profession, pharmacy had become independent of medicine, just as grammar is separate from the art of composition, prose from poetry, and so forth. Pharmacy, therefore, was recognized as a provider of essential tools and a separate profession with high standards[125].

One of the finest definitions of the pharmacist, his role and his profession, was given by Abu ar- Rayhan al-Biruni (d.1048). In his work *as- Saydanah fit-Tibb*, al-Biruni defined the Pharmacist (as-Saydanani} "*as the professional who is specialized in the collection of all drugs, choosing the very best of each simple or compound, and in the preparation of good remedies from them following the most accurate methods and techniques as recommended by experts in the healing arts.*" A description that varies only slightly from the modern one[126].

Al-Biruni promoted the idea of academic training of pharmacy students coupled with day-to-day practical experiences with drugs. As a result, he said these trainees would become more and more familiar with the shapes, physical properties, and kinds of drugs. They would then be able to differentiate one from the other and would possess the know-how, a knowledge that could not be taken away from them. He also argued that a pharmacist should also be able to substitute or to discard one drug for

[124]Tschanz, (2003)
[125]Ibid
[126]Ibid

another. The knowledge of how drugs work on the body (pharmacology), however, is more important than the mere skill of preparing them, he said. In substituting one drug for another the various actions of each should be considered and accounted for. Cure can be sought through a draft, ointment, anointing oils, or by fumigation. Thus, in seeking a substitute, all these and other applications should be considered. Without this knowledge one falls short of professional goals[127].

4. Ibn Sina and Clinical Trials

Discussing Ibn Sina is like describing a force of nature. In the area of pharmacy he made many contributions, including describing 760 drugs. Perhaps his most lasting achievement in the field of pharmacy was his work in laying down the following rules for testing the effectiveness of a new drug or medication. These principles still form the basis of modern clinical drug trials[128].

1. The drug must be free from any extraneous accidental quality.
2. It must be used on a simple, not a composite, disease.
3. The drug must be tested with two contrary types of diseases, because sometimes a drug cures one disease by its essential qualities and another by its accidental ones.
4. The quality of the drug must correspond to the strength of the disease. For example, there are some drugs whose heat is less than the coldness of certain diseases, so that they would have no effect on them.
5. The time of action must be observed, so that essence and action are not confused.
6. The effect of the drug must be seen to occur constantly or in many cases, for if this did not happen, it was an accidental effect.

[127] Tschanz, (2003)
[128] Ibid

7. The experimentation must be done with the human body, for testing a drug on a lion or a horse might not prove anything about its effect on man.

5. <u>Maturity</u>

The largest and most popular of materia medica manuals was that by Ibn al-Baytar, who was born in Malaga in the kingdom of Granada towards the end of the 12th century and became `Chief of Botanists' in Cairo in the first half of the 13th century. His Arabic treatise, *The Comprehensive Book on Materia Medica and Foodstuffs (Kitab al-Jami` li-mufradat al-adwiyah wa-al-aghdhiyah),* was an alphabetical guide to over 1400 samples taken from his own observations as well as from 150 written sources that he names. Al-Baytar’s manual formed the basis of many subsequent manuals on medicinal substances, including that written in the 18th-century by Muhammad Husayn ibn Muhammad Hadi al-`Aqili al-`Alavi, a practitioner in India and grandson of a well-known Indian practitioner[129].

A century later Abu al-Muna Ibn al-'Attar of Cairo penned a manual on practical pharmacy. Ibn al-'Attar, an experienced pharmacist, dedicated the manual to his son, also a pharmacist, who was about to take charge of the business in place of his aged father. He gave attention to the important practical aspects of pharmacy, the upkeep of the drug store, and good management. He also emphasized skill in the technique of compounding and dispensing pharmaceutical preparations, and knowledge of the materia medica[130].

[129] Tschanz, (2003)
[130] Ibid

V- Theological Influence on Medicine

The fall of the Western Roman Empire and the rise of monotheistic religions of Christianity in the West and Islam in the East changed the way society interacted with science and medicine. Gone were the specific pagan gods for healing. In place was a singular deity and the religions construct in the form of the Christianity and Islam. The Middle Ages saw both Christian and Islamic theologians and Medical personnel encounter the dichotomy of their theology and role as healers in parallel yet unique ways[131].

Christianity and Islam developed different interactions with medicine throughout the Middle Ages. While both theologies influenced the way the sick and disabled were treated and the social and institutional structures that developed in each respective society, they did so through different levels of involvement and oversight. Ultimately, Christianity imposed restrictions on medicine while Islam allowed more organic less restricted growth[132].

Christianity and medicine established a contentious relationship early in the Middle Ages and this continued consistently throughout. Christianity fought medical science from its inception with scholars and medical practitioners being more resistant to accept the Greek predecessor's medical scholarship, because they opposed the pagan roots of the Greek texts. Instead of looking past the pagan wording and acknowledging the treatments prescribed, Christian hierarchy in Europe closed the school in Athens, and therefore delayed medical study and development in Europe for hundreds of years[133].

[131]Osborn, (2017), A Comparison of Islamic and Christian Influences on Medicine inthe Middle Ages, unpublished dissertation.
[132]Ibid
[133]Ibid

Christianity not only conflicted with the foundational medical texts but also fought against the idea that God wanted Christians to seek medical treatment. The belief that the Christian God was benevolent and omnipotent detracted from individuals' seeking medical care because curing illness, to the devout, was in God's hands alone. Christian theological source texts like the Bible and St. Augustine's Confessions focused on the miraculous healing of God and the saints instead of acknowledging healing as an act of God through human healers. This conflict of spiritual healing versus physical healing became the defining discourse in Medieval Christian medicine[134].

The dualism of body and soul dictated not only who sought treatment but also who treated the sick. Legislation required monastic and mendicant healers to obtain confessions before performing any physical medical treatment to those under their care. At all times the belief that spiritual health was superior to physical health appeared irreconcilable to the Christian hierarchy dictating medical care. The connotation that moral sickness was underlying any physical sickness led Christian society to ostracize the weakest members of society in the lepers, mentally ill and to a lesser extent the physically disabled[135].

Medical practitioners in monasteries and friaries were constantly working around, avoiding, or ignoring consular and papal legislation to continue medical scholarship and practice, as shown by the volume of restrictions that were issued and re-issued to restrict their practice. Christian hierarchy increasingly limited and it ultimately forbade clergy from attending university and performing medical procedures. The focus of Christian hierarchy was not on providing better physical care for the patient but on the soul[136].

[134]Osborn, (2017), p.99
[135]Ibid
[136]Ibid

The most positive outcome of Christianity's interaction with medicine was the establishment of Christian charity. The belief that entire groups of people such as those suffering from leprosy were completely rejected from society induced a movement of charity, not only towards lepers but also the poor and other marginalized members of society. Christian development of social support services for the poor and sick as well as elevating medical knowledge in universities showed a balance of religious authority and medicine[137].

Islamic society did not associate all illness and disability with sin and moral sickness as their Christian counterparts. By removing moral deficiency from cases of leprosy, mental illness, and physical disability Islamic society deemphasized shame and ostracism and was much more inclusive medically and socially. Islamic balance of more secularized medicine was much more inclusive treating people of different religions and allowing Jewish and Christian physicians to practice in Islamic hospitals[138].

It would be remiss to discuss the foundations of the interplay between religion and medicine without discussing the scriptural authority of the Qur'an. The Qur'an did not specifically detail medical practice or the role of the physician in society, and yet it outlined religious goals of caring for others and charity. In the Qur'an, in which otherwise so many questions about human living are discussed and rules laid down, neither the doctor nor medicine are anywhere mentioned; however, subsequent theological texts namely the Hadiths do contain information about how Muhammad treated certain illnesses and what he advised for practitioners and patients[139].

The Hadiths, which represent the Prophet's extra Qur'anic teaching, are the body of traditions that make up the Muslim community. The Hadiths, second only to

[137]Osborn (2017), p.99
[138] Ibid, pp.100-101
[139] Osborn, (2017), pp.18-19

the Qur'an in developing Islamic jurisprudence, largely represents the opinion of the early generations of Muslims and can be taken as a vast commentary by these generations upon the Qur'an and the performance of the Prophet[140]. This Islamic jurisprudence that the Hadith created were not only laws for daily living, but the foundation of preventative medical care by means of cleanliness and hygiene. The Hadiths later gave rise to a medical genre called Prophetic Medicine and while historians debate problems with source criticism of the Prophetic medicine, mainly that the Prophet could not write it in its entirely, to Muslim in the Middle Ages, the Prophetic Medicine was the quintessential guidebook to health and healing[141].

For a proper appraisal of the Muslim contribution to medical science it is important to ascertain its position in Arabia at the birth of Islam. The country, as everyone knows, was at the time torn by internecine wars and family feuds. Ignorance was abysmal and education non-existent. The city surgeon (jarrah) cauterized wounds, sustained in war, or applied obscure ointments as healing balms, and the village apothecary administered simples for simple ailments. People generally were living under most unhygienic conditions. Such was the dismal medical background when the Prophet of Islam started preaching. Early in his career he said that knowledge was of two kinds, that of religions and that of the bodies (i.e., of medicine). Inspired by the Qur'anic injunction, he preached moderation in all walks of life. Realizing the miserable lack of medical facilities, he advocated prophylactic measures as is evident from the following[142].

Sa'di, the great Persian poet, philosopher, and traveller, relates the story of an eminent Persian physician who was sent by the Persian king to the Prophet to minister to his own as well as to his followers' needs. For a long time after the physician's

[140]Pormann and Savage-Smith, (2007), *Medieval Islamic Medicine*, Edinbrugh, Edinburgh University Press, p22.
[141]Ibid
[142]Sharif, (1963), *A History of Muslim Philosophy*, Alhassanain, Karachi, p.552

arrival in Mecca no one called on him or sought his treatment. Driven by ennui he approached the Holy Prophet and complained of his forced odium. The Prophet's reply was: "*These people do not eat until they are hungry nor drink until thirsty and then cease eating while a desire for food still remains.*" That must be the reason for their perfect health, said the physician. But medicine was not the Prophet's mission. He had dedicated himself to the moral and spiritual uplift of humanity at large. Winwood Reade says, "*Muhammad's career is the best example that can be given of the influence of the individual in human history. That single man created the glory of his nation and spread his language over half the earth. The words which he preached to jeering crowds are now being studied by scholars in London, Paris and Berlin ... and in obscure villages situated by obscure streams."*[143] The Prophet's biggest miracle was that he brought unity among the fighting Arabs with the result that they adopted one goal; and soon the Arabs as one nation became rulers of half of the civilized world. Care of the sick and wounded was but one facet of the Prophet's humanitarian personality[144].

Prophetic medicine or *at-tibb an-nabawi* drew upon Arab and Greek sources and was used both counter what was considered heathen Greek medicine as well as convert it to more palatable techniques[145]. Writings of the Prophetic Medicine had minimal surgical treatments aside from circumcision, instead, more minimally invasive options were described such as cautery, bloodletting, and cupping. Preventative actions of regulation of diet were also described as a key to health in conjunction with naturalistic medicines. The Prophetic Medicine was clear that medicine was a combined effort between God and man in that God provided the cure for diseases, but

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[143]Winwood Reade, (1872),*The Martyrdom of Man*, Walts & Co., London, p. 214, quoted in Sharif,(1963)

[144]E. G. Brown, *Arabian Medicine*, Urdu translation with commentary by Sayyid `Ali Ahmad Nayyar Wasti, p.15.

[145]Ullmann, M. (1997), *Islamic Medicine*, Edinburgh University Press, p.5

man was required to obtain the cure and use it properly. A quote universally attributed to the Prophet in the Hadith is, "*God has sent down a treatment for every ailment*". This quote made a very clear statement that healing was through God in the Islamic faith and stressed the importance of man's connection to medicine. Furthermore, Abu Bakr Rabi ibn Ahmad al-Akhwini al-Bukhari wrote in his *Guide for Students* of the importance of medicine as it relates to theology saying, "*Wise men have said that it is incumbent upon every person to learn of the sacred law of when a person knows the sacred law he is immune from going astray. Second, he must know some medicine in order to preserve his health so that quack doctors will not be able to destroy him*." This belief is repeated throughout the Prophetic Medicine and laid the foundation of Islamic medicine that after faith, medicine is the most important service from God's perspective[146].

Islam stressed from the very beginning the role of knowledge (*'ilm*) as the driving force in religion and, thereby, in all human life. Admittedly, Qur'anic *'ilm* has the religious connotation of acknowledgment of the premises of religious existence and acquaintance with the religious duties of the Muslim, and the word soon came to refer specifically to 'knowledge' of Islamic religious doctrines and obligations. However, *'ilm* never lost its wide and general significance. Thus the interest in knowledge for its own sake, in systematic learning and in the sciences as expressions of man's thirst for knowledge, was greatly and effectively stimulated. Without this central position of 'knowledge' in Islam and the almost religious veneration extended to it, the translation activity would presumably have been less scholarly and less extensive. It would probably have been confined to the absolutely essential and immediately useful to a much greater degree[147].

[146]Osborn, (2017)

[147]Rosenthal, F.(1975), *The Classical Heritage in Islam*, Translated from German by Marmorstein,Berkley and L.A, University of California Press, p.5

The following sayings of the Prophet exhibit the importance he attached to the seeking of knowledge:[148]

1. *Seek ye knowledge from the cradle to the grave.*
2. *To seek knowledge is the duty of every Muslim man and woman.*
3. *Seek ye knowledge even if it be in China.*
4. *The ink of the scholar is more holy than the blood of the martyr.*
5. *He who leaveth his home in search of knowledge walketh in the path of God.*
6. *He dieth not who seeketh knowledge.*

The spread of Greek traditions was stifled in the West by the extreme Roman utilitarianism which was followed by the theological expediency and later by a theological domination which seemed for a long time to destroy every hope of genuine scientific revival. After the birth of Islam, the Arabs on the other hand were fired with the zeal for knowledge[149].

The Arabian environment in which Islam had its roots was in contact with Hellenistic civilization. This generated in Islam a certain affinity with classical culture. Soon there came the translation activity bringing Islam and Greece together in a consciously creative act. The heritage of classical antiquity was revived with the aid of scholarly research. The result was a new outlook on life, giving Islam an intellectual direction. Thus was born what we call Islamic culture[150].

In medicine the Arabs translated Hippocrates, Galen, and Dioscorides. Cumston says that the Arabs extracted the most important material from Greek writings and placed it in relief, leaving aside everything that was superfluous. One has merely to read Galen and afterwards ibn Sina in order to see the difference. The former was

[148]Sharif, (1963), p.554
[149]Ibid
[150]Rosenthal, F.(1975), p.12

obscure, the latter perfectly clear; order and method reign in the latter, which in the former we seek in vain[151].

The foundation of interaction between medicine and religion in the Islamic Middle Ages was not without conflict. There was not only conflict in pagan writings converting to monotheist but also religion laws that governed the implementation of pagan treatments. Islamic law conflicted with treatments in the pagan medical texts for a number of reasons. Islamic law relaxed on some of these conflicts, however. Shari'a law forbade men and women from examining each other but was flexible in the cases of illness. It was permissible for women to treat men and vice versa and from them to look at and examine each other. Women even traveled in battle to treat wounded. This flexibility had its limits, however, in the end, Islamic law superseded foundation of the medical treatment stating, "*That which is unlawful in religion cannot be made lawful on the basis of something merely conjectural (medicine).*"[152] Treatments that included any parts of pigs were re-written to exclude the forbidden animal and alcohol was removed from treatments, as it was forbidden[153].

The Islamic foundation of healthcare is more concrete about when to seek care. In Islamic tradition, it was not only distinctly to seek care but obligatory. With the Muslim outlook that spiritual health was connected to physical health, it was imperative to seek treatment for God to cure the ill. Similarly, the Hadith and Qur'an recognized illness as God's trial of people and a way for spiritual cleansing. The Prophetic Medicine commanded a person to seek medical care and believed illness and treatment had redemptive effect on a person[154].

[151]Sharif, (1963), p.554
[152]Rahman, F.(1987), *Health and Medicine in the Islamic Tradition*, quoted in Osborne, (2017)
[153]Ullmann, M. (1997), *Islamic Medicine*, Edinbrugh, Edinburgh University Press, p.31
[154]Osborne,(2017)

Though the Prophetic Medicine commanded a person to seek medical care, it also glorified those who did not survive this illness stating, "*Whoever dies in any illness is a martyr.*"[155] A martyr, shahid, was someone who died serving God and had a place in paradise. Prophetic medicine believed the suffering of those who were bed ridden should not grieve over his or her sickness for it was a gift to die and meet God. The Qur'an says, "*Think not of those who are slain in Allah's was as dead. Nay, they live, finding their sustenance in the presence of their Lord; they rejoice in the bounty provided by Allah. And with regard to those left behind, who have not yet joined them (in their bliss), the (Martyrs) glory in the fact that on them is no fear, nor have they (cause to) grieve.*"(the Qur'an 3.169-170) Illness also allows others to show their mercy and gifts of healing that were gifted by God. Illness offered both the sufferer and the healer in Islam to achieve martyrdom though intent to do God's will[156].

Islam did not struggle with the healing of the spirit conflict with healing of the body. Prophetic Medicine focused health of the whole person and did not separate the spiritual, psychological, physical and moral elements. The Qur'an does not subscribe to the doctrine of a radical mind-body dualism that Christianity does. "*The term nafs, which occurs so frequently in the Qur'an and is translated into English as 'soul' actually means 'person' or else is a reflective pronoun meaning 'itself,' 'himself,' or 'herself.'*"[157] In chapter five it was used to mean yourselves and said, "*O you who have believed, upon you is [responsibility for] yourselves. Those who have gone astray will not harm you when you have been guided. To Allah is you return all together; then He will inform you of what you used to do*" (The Qur'an, 5.105). This lack of definition between body and soul carried throughout medieval medical writing in the Islamic East. Ibn Sina wrote that the mind and body were affected by each other, and that,

[155] Rahman, F.(1987)
[156] Osborne,(2017)
[157] Rahman, F.(1987)

even though he believed the mind to be superior it was impossible to have health of one without health of the other or treat illness separately. Regarding mental health he wrote, "*in safeguarding the emotions the mind and body are at the same time maintained*."[158]

The establishment of Islam as primary monotheist religion moved to eradicate paganism and magic. Hippocratic medicine, based on the humoral theory, fit well into a monotheistic paradigm because it internalized health and made it more patient-focused instead of external forces. The Middle Age Islamic physicians expanded on this Greek idea by establishing individuality in the balance of the humors[159].

1. Prevention and Treatment of Disease

Without an understanding of germ theory or contagion, Medieval Islamic society explained causes of disease through personal sin, societal sin, evil spirits, or humoral imbalance. Early fifteenth-century medical writer al-Azraq points out that before all else medicine is grounded in theology in which causes of disease are sin or God's divine punishment. He wrote in *Medical Benefits Made Accessible* that, "*medicine is a science whose benefits are great and whose nobility, prestige, and fame are recognized and whose roots are established in the book (Qur'an) and the example (Sunna).*"[160]Islam combined this belief of theological basis of medicine with the earlier humoral imbalance theory of disease causation.

Muslim physicians and writers Abu Bakr, al-Razi, and Ibn Sina in the tenth and eleventh centuries emphasized the Islamic continuation of Greek disease causation theories of the non-naturals and wrote on topics as far ranging as diet to architecture

[158]Gonzalez, C.J,(1973), *The Canon of Medicine of Avicenna*, AMS Press, NY, quoted in Osborne,(2017)
[159] Osborne,(2017)
[160]Ibn Qayyim. *Al-Tibb*, quoted in Rahman,(1987)

of house windows to admit healthy light and air and avoid illness. Ibn Sina in his *Canon* described how bad air affected the body, "*when the air that has undergone such putrefaction arrives at the heart, it rots the complexion of its spirit and then after surrounding the heart, rots it. An unnatural warmth then spreads all around the body, as a result of which a pestilential fever will appear. It will spread to any human who is susceptible to it.*"[161]

Disease transmission in Islamic society began in the Hadith that said, "*The owner of sick animals should not drive these to the owner of healthy animals.*"[162] This showed Islamic physicians who were grounded in theological texts understood the concept of being near a sick person could lead to illness and they merged this idea with Galen's theory of seeds of disease that could be transmitted between people. Muslim physicians also discussed this idea of seeds of disease and in the ninth century using the word "*i'da*" which is understood more as "transmission and not differentiating between infection (direct transmission of bacilli) and contagion (transmission of parasites and the like)."[163]

Disease prevention in the Islamic world was anchored in religion. Islam had very specific rules and laws regarding purification and hygiene that emphasized cleanliness consequently preventing disease transmission. Hammams or public baths were in every town and all levels of society took part in bathing rituals. Islamic Sacred Law controlled rules details such as volume of water that needed to be used to purify and the quality of water was even divided into categories based on its ability to purify. In *Reliance of the Traveler*, fourteenth-century Islamic jurisprudence also dictates of details washing before prayer, *wudu*. Details are extensive on the appropriate way to wash the face including facial hair, clean the feet including between the toes and

[161]Gonzalez, C.J,(1973), *The Canon of Medicine of Avicenna*, AMS Press, NY, quoted in Osborne,(2017)
[162]Al-Bukhari, *Sahih*, quoted in Ullmann,(1997), p.95
[163]Ullmann,(1997), p.87

scrape dirt from underneath fingernails. Some of these details were direct instructions from the Qur'an and the Hadith and emphasized that a prayer is not accepted without purification. Ablution, therefore, was and integral part of Islamic religion and culture and became an important societal factor in health and prevention of illness. Perfumed soap became an important industry especially in Syria where it was manufactured and exported[164].

Hygiene for the citizens of Islam was not limited to bathing; grooming and dental hygiene also played an important role in religious life and prevention of disease. Galen laid the foundation of belief that facial hair such as eyelashes and eyebrows were designed for health "naturally through a prime intention." Because bad air was seen as so detrimental to health bad breath and teeth were essential to hygiene. The Prophet was to have said, "*Were it not for my desire not to burden my community, I would have ordered them to clean the teeth before every act of worship*."[165] Sacred Law required the use of a twig or the like on the teeth and around them to remove an unpleasant change in the breath or similar. A tooth stick, *siwak*, was made from branches or roots of the arak tree, which has in recent times been shown to prevent plaque and inflammation of the gums owing to fluoride tannins and resinous substance in the wood[166].

The strict classification of ritual impurity and filth in Islamic law further controlled hygiene and transmission of illness through bodily fluids. A purification bath, *Ghusl*, was required for all minor and major ritual impurity. Bodily fluids as well as other interactions were considered filth and had specific laws requiring cleansing. Urine, excrement, blood, pus, vomit, wine, any liquid intoxicant not used to cleanse a wound, dogs, pigs, slaughtered animals, animal corpses, (apart from aquatic life and

[164]Pormann and Savage-Smith, (2007), p.135
[165]Ibid, p.138
[166]Osborne,(2017)

locusts and milk of animals) are all filth and unable to be eaten and require ritual bathing after any contact. By Islamic law requiring baths after these situations and prevention of entry to the Mosque, where large groups of people are in close contact, stunts the spread of disease[167]. Ali ibn Ridwan in *On the Prevention of Bodily Ills in Egypt* details how air, water, and food all can cause "epidemic illness" and prevention is possible by taking precautions such as boiling water and adding Armenian clay, tabashir, or garlic or using oils or flowers to perfume air[168].

When disease prevention failed and a person fell ill, the first line of treatment available to the Islamic physician in the Middle Ages was diet. Ideally, the patient was treated with food remedies, but physicians like al-Razi stressed that if diet change did not cure the illness simple remedies should be used before compound remedies. Al-Razi was very specific on limiting the amount of drugs to treat a patient. In his *Book of Experiences* treatment focused on phlebotomy, cupping, or purgatives, regimen, medication, and diet with great reliance on rose-honey and barely water[169]. Islamic physicians had a broad array of consumable medicinal remedies that they had expanded from Greek cures by utilizing locally grown flora. Islamic physicians followed the belief that God provided a cure for all illnesses, which pushed exploration of pharmaceuticals beyond the ancient uses[170].

Islamic medical sources differentiated types of physicians and surgeons based on their focus of care. Physician focused on internal medicine and balance of humors by using drugs, diet, and regimen whereas, surgeons were for more external conditions such as wounds and skin blemishes. Types of caregivers included apart from physicians, oculists, circumcisers, phlebotomists, cuppers, bone-setters,

[167]Osborne,(2017)
[168]Dols, Gamal, (1984), p.138
[169]Pormann and Savage-Smith, (2007), p.119
[170]Osborne,(2017)

cauterisers, and those who administered enemas. Barber-surgeons, phlebotomist, and cuppers were found in marketplaces and as hammam staff making them accessible to the Muslim citizen who was legally required to visit baths[171]. This proximity and daily interaction of medical care along with earlier translations of Greek surgery techniques allowed Islamic surgical expertise to mature faster and beginning in the tenth and eleventh-century medical text such as al-Razi provided extensive writings on surgery.

2. Approaches to the Plague

The plague affected the medieval world like no other disease, neither medical knowledge nor religious doctrine could make sense of prevention, causes, or treatment of plague and no other disease was fought with such futility. In the mid-fourteenth century, the Black Death spread through the Near East, Europe, and North Africa. The plague had a mythological status in the Christian Middle Ages due to its seemingly unstoppable nature and horrific symptoms and it forced physicians to observe the plague independent from any other pestilence[172].

Islamic sources were compelled to blame God as the cause of the plague. The dramatic appearance, terrifying symptoms, and high mortality rate of the plague no doubt gave additional support to arguments for the divine cause of the Black Death. Muslims saw the plague as separation of divine punishment where suffering was seen as a “punishment for infidels” and communal sin. It was also a test for the faithful, one that devout Muslims believed if a faithful person suffered and died of plague they became holy martyrs that went directly to Paradise. The religious based cause of the plague was hindered by the way it spread through communities. Islamic physicians

[171] Pormann and Savage-Smith, (2007), p.135
[172] Ullmann,(1997), p.96

who followed the Qur'an and Prophetic Medicine believed that contagion without the will of Allah was not possible. However, their faith could not explain why hundreds and thousands of people could all suffer and die of the same symptoms at the same time for either God wanted to punish everyone or there was another explanation[173].

Islamic physicians turned to Greek miasmic theory as another cause of plague. An Arabic Physician wrote "*The pestilence resulted from a corruption occurring in the substance of the air due to heavenly and terrestrial causes. In the earth the causes are brackish water and the many cadavers found in places of battles when the dead are not buried, and land which is water-logged and stagnant from rottenness, vermin, and frogs.*"[174] Bad vapors or bad air was a commonly accepted cause of plague from Hippocrates time. Muhammad ibn-al-Lakhmi ash-Shaquiri a mid-fourteenth-century Muslim Spanish author sided with theologians regarding plague spreading through God's will but also stated, "*the cause of the plague is the impurity of the air*" and that "*lung- sufferers*" are especially prone to sickness[175].

Although, contagion played a minor role in explaining the spread of epidemic disease in the Greek tradition, physicians could not help but recognize that this disease seemed to spread through contact with infected persons. Muslim religious scholars wrote many plague tracts following the initial outbreak of the epidemic, considering the possibility of contagion. Referring to the Prophetic tradition, some scholars maintained that Muhammad had proclaimed that there was no possibility of contagion since this would imply that disease might spread independent of the will of God. However, this issue was complex, and numerous Muslim authors supported the possibility of contagion revealing that there was no single Islamic position on this issue. Ibn al-Khatib (fourteenth century), for example, specifically argued that

173 Osborne,(2017)
174 Dols,(1977), quoted in York, W.H.(2012), *Health and Wellness in Antiquity through the Middle Ages*, Greenwood
175 Ullmann,(1997), p.92

experience revealed that plague was spread by contagion, and outbreaks often coincided with the arrival of people traveling from regions where the plague was raging. He supported his empirical observations by citing Hadith that he felt endorsed the possibility of contagion. The debate over the possibility of contagion continued far beyond the period of the Black Death, but those physicians who supported a contagion theory found it necessary to reconcile it with the miasmatic theory, by arguing, for example, that the sick contaminated the air around them, as well as their clothing, bedding, and utensils. European physicians also sought to reconcile contagion theory with the belief in miasmas[176].

Islamic physicians instructed anyone who could flee to avoid cities and live in rural areas to avoid infection. This way of preventing plague is even written in the Hadith attributed to Muhammad where it is written, "*if you hear that the plague has broken out in a country, do not go there; if it breaks out in a country where you are staying, do not leave it*." In addition to fleeing areas of epidemic, quarantines were set up both to prevent outsiders and goods such as linen products from infecting regions that had not received the plague and also keep plague-stricken areas isolated.

"*Infection exists, is confirmed by experience, research, insight and observation and through constantly recurring accounts. These are the elements of proof. For him who has treated or recognized this case, it cannot remain concealed that mostly the man who has had contact with a patient infected with this disease must die, and that, on the other hand, the man who has had no contact remains healthy. So it is with the appearance of the illness in a house or quarter because of a garment or a vessel; even an earring can destroy him who puts it in his ear, and all the inhabitants of the house. The illness can first appear in a town in a single house; then, from there, it can break*

[176] York, W.H.(2012), *Health and Wellness in Antiquity through the Middle Ages*, Greenwood p.111

out among individual contacts, then among their neighbors, relatives, and especially their visitors, until the breach becomes even greater. The illness can appear in coastal towns that enjoyed good health until there lands in them a man with plague, come from across the sea, from another coast where the plague already exists, as reports tell. The date of the appearance of the illness in the town tallies with the date of debarkation of this man. Many remained healthy who kept themselves strictly cut off from the outside world, like the pious Ibn-Abi-Madyan in Sale. He belonged to those who believed in contagion. He had stored up provisions for a long period and bricked up his door behind him and his large family. The town succumbed but during that period, he was not deprived of a single soul. One had repeatedly heard that places which lie remote from highways and traffic remained untouched. But there is nothing more wonderful at this time than the prison camp of the Muslims-may God free them!-in the Arsenal of Seville: there were thousands but the plague did not touch them although it practically destroyed the town itself. The report is also correct that the itinerant nomads living in tents in North Africa and elsewhere remained healthy because there the air is not shut in and the corruption proceeding from it could only gain a slight hold."[177]

Avoidance and quarantine were not always possible or effective and Islamic physicians turned to treatments utilized on other illnesses of the Islamic Middle ages. Bloodletting, cupping and cautery were used on plague bulboes that Islamic sources thought to be spots where the poison pooled. Islamic physician ibn Khatimah wrote that the thickness of the blood determined the location of these buboes and that the lightest appeared near the ears and the heaviest "hurled to the groin." In further efforts to restore balance, diet prescriptions were utilized in accordance to Sacred Law that

177Ibn al-Khatib, quoted in York, W.H.(2012) pp.94-95 forbid alcohol or gold be consumed. With these prescriptions, plague tracts written by Muslim physicians following the initial outbreak of the epidemic, more advanced anatomy and scientific understanding Islam was still helpless to plague.

3. Approaches to Military Medicine

Aside from communicable disease, minor surgeries, and plague, a major component of healthcare in the Middle Ages was that of military medicine due to the necessity for treating battle injuries in the near constant fighting of the Middle Ages.

Hygiene was a large focus in Islamic society, which was ruled by rituals including washing, teeth cleaning and nail scraping. Even with this focus in Islamic culture, hygiene and health suffered for soldiers during war. An Egyptian text describes a soldier as *"he is called up for Syria. He may not rest. There are no clothes, no sandals. His march is uphill through mountains. He drinks water every third day; it is smelly and tastes of salt. His body is ravaged by illness."*[178]Though Islamic physicians could not control all aspects of hygiene during military campaign, post-injury hygiene was advanced for its time. Islamic post-operative and post-injury treatment consisted of cleaning the wound with antiseptics including wine and they greatly valued the prevention of infection. Wine used to clean wounds had specific exemption in Islamic law and was not filth like other intoxicant beverages. Islam's amenable relationship with medicine meant that flexibility such as using intoxicants for wound cleaning and also allowing physicians to treat the wounded instead of leaving care to the divine for natural healing[179].

Islamic armies valued medical expertise and traveled with physicians on campaign. Not only did the army benefit significantly from the proximity of medical

[178]York,(2012), p.200
[179]Osborne,(2017)

care but physicians expanded their expertise and advanced medical practice through military experiences. In the late tenth century, Al-Zahrawi wrote about his experiences as a surgeon with the army and detailed his work in a chapter on surgery. Al-Zahrawi described surgery for the treatment of abdominal wounds resulting in protrusion of the intestines. He modified earlier methods for suturing and also presented a case history of a man wounded in the abdomen with a knife. His surgery writing would then be taught to physicians studying in urban Islamic hospitals.[180]

Islamic armies also developed mobile military hospitals that not only housed physicians during battle but tools, structures and medicine. Mobile military hospitals provided proximity and timely access to care allowing physicians to stop blood loss and prevent shock in wounded soldiers and giving Islamic armies greater success at caring for casualties. Some texts even mentioned the “use of structures by indigenous surgeons to bring together the edges of wounds.” Few details remain of how the structures functioned, but there appeared to have been successful despite the lack of sterility[181].

With most military wounds, arresting hemorrhage was the most immediate concern. Islamic medical writers understood the difference between arterial and venous bleeding and the severity difference that required more aggressive treatment. Albucasis wrote between tenth to eleventh centuries in Islamic Spain on how to treat an arterial bleeding:

“*Very often there occurs bleeding from an artery which has been cut either by an external wound or in opening an abscess or in cauterizing a part of the body and so on, and it is difficult to stem. When this happens to anyone, quickly apply your forefinger to it and closing it properly until the bleeding ceases under your fingers*

[180] Osborne,(2017)
[181] Ibid

and nothing comes out. Then put in the fire several olive cauteries, small and large according to the size of the wound and the size of the opening of the artery and bring a cautery right down on the artery itself, after promptly removing your finger, and hold the cautery upon it until the bleeding ceases."[182]

4. Medical Education

Islamic medical learning was not as regulated or driven by theological hierarchy. It was, however, deeply driven by The Qur'an and Hadith, which valued education and acquiring knowledge. Islamic medical scholarship started in the eighth and ninth centuries with the translation of ancient Greek medical texts. By the tenth century, Islamic scholars shifted their attention from translation efforts to producing new medical scholarship through treatment and observation[183]. This focus on treatment and hands-on observation featured prominently in medical education as well. There was less institutionalization of medical learning in the Islamic East, where there were multiple ways to become a physician.

Islamic physicians learned not in universities, but instead, through mentorship from a teacher or family member, self-tutoring, or through classes at a hospital. The Islamic hospital essentially functioned as medical school with much more student-patient interactions. Hospitals certainly had libraries that contained medical books where students could study medicine on their own or under the guidance of teachers and some also had lecture rooms where hospitals taught students. Students at hospitals were able to interact with patients daily, and due to the nature of the Islamic hospital being very large and inclusive of many diseases and disorders, students had

[182]Spink, M.S. and Lewis G.L.(1973), *Albucasis On Surgery and Instruments: A Definitive Edition of the Arabic Text with English Translation and Commentary*, Berkley, University of California Press, p.162.
[183]York,(2012), p.33

access to many situations. Medieval Islam's emphasis on acquiring knowledge, instead of having a restrictive hierarchy and control, led to a much more experience based medical education and the absence of distinct formally organized medical institutions for learning[184].

The area that Islamic theology had the most impact on Islamic medicine of the Middle Ages was in the curriculum. There was no set curriculum for Islamic medical learning but there were some theologically controlled areas most notably dissection and pharmacology involving intoxicants. Ibn al-Nafis who made great advances in cardiac, pulmonary, and circulatory anatomy said that he avoided the practice of dissection because of the shari'a and his own 'compassion' for the human body. Whether Ibn al-Nafis advance anatomical knowledge through dissection or surgery is debated still, however, there were others in the twelfth and thirteenth century East that proposed the Qur'an's belief in learning and gaining knowledge was of superior importance than the restriction on dissection. {Islamic theologian, Al-Ghazali, encouraged the study of anatomy and use of dissections as a method of gaining knowledge of God's creation, physicians in the Western Islamic area took their cue in following his stance.} Hence Ibn al-Nafis, who made great advances in cardiac, pulmonary, and circulatory anatomy said that he avoided the practice of dissection because of the shari'a and his own 'compassion' for the human body. Whether Ibn al-Nafis advanced anatomical knowledge through dissection or surgery is debated still, however, there were others in the twelfth and thirteenth centuries East that proposed the Qur'an's belief in learning and gaining knowledge was of superior importance than the restriction on dissection.[185]

[184] Osborne,(2017)
[185] Osborne,(2017)

Islamic physicians were very concerned with the aptitude of medical practitioners, but instead of addressing quacks and uneducated practitioners through theological writing, Islamic medicine self-regulated to create a divide between educated physicians and practitioners who worked in the marketplace with little formal training or education. There were no bishops or chancellors granting licenses to competent medical practitioners instead the examination of physicians was done by market inspectors, *muhtasibs*, or the ruling authority in larger cities appointed a chief or head of medicine, *ra'is al-atibba*, who was a physician responsible for maintaining medical standards.[186] Islamic medicine emphasized testing on not only theoretical and physical medicine, but also what was considered to be a good physician, which included, demeanor, appearance, and ethical practice. Islamic medical study of the Middle Ages focused on the treatment of patients in a very hands-on way, with much more emphasis on practical knowledge.

Al-Razi believed the student should be tested through oral exams on both theoretical and practical knowledge and if the student failed the theoretical he saw no point in examining him in practical knowledge. Islamic medical education was in total much more secular and less dependent on theological rules but grounded in the belief that knowledge of medicine was paramount to Islamic teachings and the medical profession should be regulated so that only competent physicians should practice[187].

European medical schools in the Middle Ages grew out of cathedral schools and monasteries where Arabic medical texts were translated and copied. Deeply rooted in Christianity, medical study was eventually removed from monastic and mendicant infirmaries and institutionalized into the medieval universities. Only towards the late Middle Age that universities that had theological schools often became larger

[186]Pormann and Savage-Smith, (2007), p.87.
[187]Osborne,(2017)

universities that incorporated medicine into their liberal arts education. Salerno, Montpelier, Bologna, Paris were the four main medical schools at the beginning of the thirteenth century, and they drew students from across Europe[188].

In conclusion Christianity and Islam changed in the relationship between theology and medicine through their monotheistic lenses. Christianity was more contentious and rigid towards medicine and science generally, {but by the end of the eighteenth century Middle Ages Christianity, through the establishment of university medical schools and elimination of the higher clergy from medical practice, that the final balance of medicine and religion, it had been fighting for throughout the Middle Ages, was found.} Whereas Islam's more inclusive, less theologically restricting approach to medicine led to great advancements, especially in pharmacology and had more rational approaches towards social phenomena that would later be implemented by Christian Europe. The two theologies, at different stages in time, influenced medical care, societal views of the patient and institutional structures while above all establishing that theology and medicine were constantly intertwined.

VI- The roots of Clinical Trial Methodology

Clinical trials and their correct methodology are hallmarks of modern medicine. It is now accepted that without well-designed randomized controlled trials, the efficacy of a treatment method cannot be ascertained reliably. Similar to many other modern scientific concepts, the roots of clinical trial methodology can be traced back many centuries. However, the main Western sources on the history of medicine have the dominant, but mistaken, opinion that the breakthroughs in the concept of experimental medicine started in Europe during the Renaissance. In fact, many

[188] Osborne,(2017)

important aspects of clinical trial methodology can be traced back to antiquity.[189]Medieval Islamic medicine introduced several aspects of medical research which anticipated modern clinical trial designs. The need for experiments in medical practice, the importance of animal studies before treating patients with a drug and acknowledgment of the differences between the physiologies of animals and humans, treatment comparisons to a control group, and introducing statistics to medical research can be traced back to the scientific insights of this golden period.

1. Critical appraisal of previous knowledge

One of the important features of medicine and other sciences during the medieval Islamic era was that it developed in a logical and scientific way starting first with a thorough review of the literature. Islamic scholars critically appraised the translated heritage of previous civilizations rejecting what was superfluous and accepting only what proved to be true in the light of their own observations, experience and experimentation; a mode of analysis that constitutes the basis of scientific research190.

This mental attitude of being critical in their appraisal of the literature did help the medieval Islamic scholars, not only in checking the validity of previous knowledge but also in adding original new contributions. They were ready to test by experiment what they got in theory, and to tabulate and systematize their findings to produce original scientific work. Their works are full of statements to this effect[191].

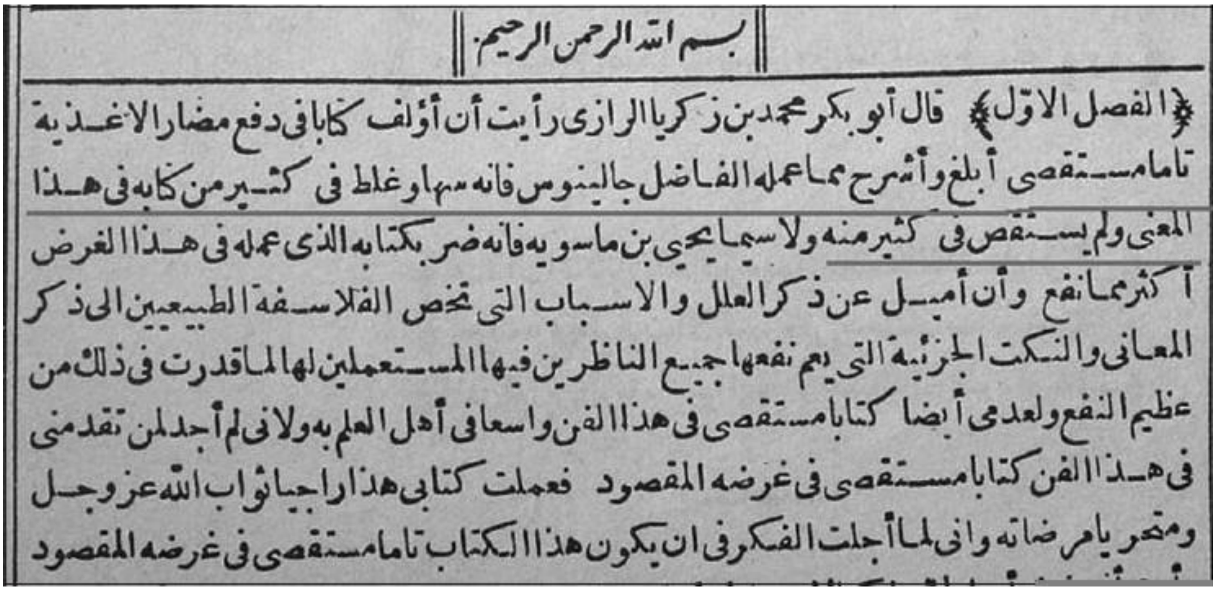
The critical appraisal of knowledge even if it came from famous authorities was obvious in the Medieval Islamic era as early as the 9th century. An example is shown

[189]Zarvandi, M. and Sadeghi, R.(2019), Exploring the roots of clinical trial methodology in medieval Islamic medicine

[190]Rabie, A.H.(2011), "Experimental Medicine 1000 years ago", Urology Annals, May-August; 3

[191]Ibid

in the statement by Al-Razi in the opening section to his book on diet therapy *Manafi' al-Aghdhiya wa Daf'i Madhârriha* translated as follows:


بسم الله الرحمن الرحيم

﴿الفصل الاول﴾ قال أبو بكر محمد بن زكريا الرازى رأيت أن أؤلف كتابا فى دفع مضار الاغذية
تاما مستقصى أبلغ وأشرح مما عمله الفاضل جالينوس فانه سها وغلط فى كثير من كتابه فى هذا
المعنى ولم يستقص فى كثير منه ولا سيما يحيى بن ماسويه فانه ضر بكتابه الذى عمله فى هذا الغرض
أكثر مما نفع وأن أميل عن ذكر العلل والاسباب التى تخص الفلاسفة الطبيعيين الى ذكر
المعانى والنكت الجزئية التى يعم نفعها جميع الناظرين فيها المستعملين لها لما قدرت فى ذلك من
عظيم النفع ولعدمى أيضا كتابا مستقصى فى هذا الفن واسعا فى أهل العلم به ولانى لم أجد لمن تقدمنى
فى هذا الفن كتابا مستقصى فى غرضه المقصود فعملت كتابى هذا راجيا ثواب الله عز وجل
ومتعرضا لمرضاته وانى لما أجلت الفكر فى ان يكون هذا الكتاب تاما مستقصى فى غرضه المقصود

Figure 3: Al-Razi,(c.865-925), On diet therapy (Manafi' al-Aghdhiyah wa-Daf' Madharriha) Part of page 2 with added underlining to highlight relevant text.

"*I decided to author a complete and wide-ranging book on how to keep away the side effects (harm) of nutrients. I decided to make the book more self-explanatory and comprehensive than the work compiled by the honorable Galen. That is because Galen in his book on the same topic overlooked, made errors and failed to cover the subject fully in many areas*"[192]

Al-Razi's reliance on his own observation, experience, and experimentation is also quite obvious in all sections of his encyclopedic work *Al-Hawi* (*Liber Continens*)as well as in other work, such as *Kitab al-Shukuk 'ala Galinus* (Doubts about Galen) in which he discussed various points of contradiction he had with Galen's medical views. This scientific critical attitude is also evident in Al-Razi's practice as frequently seen in his *Al-Hawi* book when commenting on drugs

[192]Al-Razi,(c.865–925) *Kitab Manafie al-Aghdhiyah wa-Dafei Madarrihah.*Dar Sadir, Beirut, Undated Offset Reprint. 1st ed. Cairo: Al Matbaa Al Khayriaa; 1305 H (1888 CE). p. 2.

described by predecessors, or by contemporaries, but not tried by him. In such instances, he usually states that he has to verify the validity of the mentioned drug actions[193].

Ibn Sina basically followed the methodical, analytical line originated by Al-Razi in all his works. Here is just an example from the section on simple drugs in his famous *Kitab al-Qanun fi al-Tibb* (The Canon of Medicine):

"{Bladder stone}:

Some people stated that the stone formed in the urinary bladder if [prepared as medication and] drunk by a patient suffering from the same condition, will dissolve [his] bladder stones. And this is among the medicines I do not approve."[194]

Ibn Sina underscored the importance of critical appraisal of previous knowledge. In his magnum opus he mentioned that:

"Someone may tell us that medicine is divided into theoretical and practical subdivisions and by considering it as a science we have considered it as entirely theoretical. We shall respond by mentioning that some crafts and philosophy have theoretical and practical portions, and medicine, too, has theoretical and practical subdivisions. If it is considered that some parts of medicine are theoretical and other parts are practical, this does not mean that theory teaches medicine and the practical part puts it into practice—as many investigators in this topic believe. One should be aware that the purpose is something else: it is that both sections of medicine are science, but one part is the science dealing with the principles of medicine, and the other with how to put those principles into practice."[195]

[193] Rabie, A.H.(2011)
[194] Ibn Sina, (c.980–1037) Kitab *Al-Qanun Fi Al-Tibb (The Canon of Medicine)* Vol. 1. Cairo, Bulaq Edition; 1877. Book 2; p. 326. Quoted in Rabie, A.H.(2011)
[195] Ibn Sina, (c.980–1037). *Kitab Al-Qanun Fi Al-Tibb (The canon of medicine*), Cairo, Bulaq Edition, 1877, p. 5. Quoted in Zarvandi, M. and Sadeghi, R.(2019)

The importance of experience versus scientific works of previous scholars was a durable legacy of Ibn Sina's teachings[196].

The same scientific method of reliance on direct observation, experience, and experimentation is also evident in works of all the other Islamic medical scholars subject of this study. For an example, in his book *Sharh Tashrih al-Qanun* (Commentary on the Anatomy of the *Canon*), Ibn al-Nafis (1210-1288 CE), stated that:

"*However, as regards the function of organs, we rely only on what is dictated by investigative observations and accurate research; not caring whether it conformed with, or differed from, the opinions of those who came before us.*"[197]

2. Clinical observation and case reports

A new rational approach to the care of patients was also developed by Al-Razi early in the 9th century. Following Hippocrates' example in recording cases, al-Razi stressed the fundamental importance of documenting the characteristics and treatment of hospital patients, and more than two thousands of these case notes have survived. In Doubts about Galen (*Al-Shukuk ʿala Jalinus*), al-Razi referred to registers of hospital patients' names and notes as a basis for criticising Galen[198]:

"How many things have I observed in the hospitals in Baghdad and Rayy, and in my own home area. I shall explain the many meanings of these things. I recorded the names of those whose situation developed in accordance with these books [by Galen],

[196] Zarvandi, M. and Sadeghi, R.(2019)

[197] Ibn Al-Nafis,(c.1210-1288*), Kitab Sharh Tashreeh al-Qanon*, Qattaya, S. (Edi), Cairo, al Hayaa al Masreyya al Aamma Lillkitab; (1988); p. 17.

[198] Pormann, P.E. (2013). Qualifying and quantifying medical uncertainty in 10th century Baghdad: Abu Bakr al-Razi. *JLL Bulletin: Commentaries on the history of treatment evaluation (https://www.jameslindlibrary.org/articles/qualifying-and-quantifying-medical-uncertainty-in-10th-century-baghdad-abu-bakr-al-razi/)*

and the names of those whose states developed exactly in the contrary fashion. The number of those whose state developed in a contrary fashion is not a small one".[199]

His rational approach was based on recording, interpreting and classifying his clinical and experimental observations. This original approach established the methodology of clinical medicine and differential diagnosis and made a lasting impact on Islamic medicine. In contrast to the lack of recorded case histories in the 10th-century Latin tradition, Al-Razi's medical practice as a clinician is attested by hundreds of case histories[200].

Scholars who came after Al-Razi like Ibn Sina, Al-Zahrawi (Albucasis, 936-1013 CE), Ibn Zuhr (Avenzoar, 1091-1162 CE), Muhadhdhab al-Din Al-Baghdadi (1117-1213 CE), and Ibn Al-Nafis continued to follow and enrich his pioneering school, giving prime importance to clinical observations and differential diagnosis. They all were keen on recording and classifying their clinical experience in the form of case histories, reports of medical experiences, and a wide variety of clinical accounts. The Islamic physicians are rightfully seen as keen observers who excelled in diagnosis and prognosis with their description of symptoms showing a precision and an originality that could be only obtained by direct study of the disease[201].

[199]Pormann P.E. (2003). Theory and practice in the early hospitals in Baghdad — al-Kaškari 'On Rabies and Melancholy'. *Zeitschrift für Geschichte der Arabisch-Islamischen Wissenschaften* 15:197–248.
[200]Rabie, A.H.(2011)
[201]Ibid

3. Probabilities in Medicine:

3.1. Conceptualising patient groups:

The hospital environment and record keeping promoted the conceptualization of groups of similar patients, for which al-Razi uses the word *jamaʿa*. One example concerns ophthalmological disorders:

"I say: I am of the opinion that bloodletting at the corners of the eye and the vein of the forehead is useful against all chronic eye diseases such as inveterate pannus, trachoma (jarab), and red 'ulcerative blepharitis' (al-sulaq al-ahmar). ***In front of me, a group (jamaʿa) was phlebotomised who were suffering from pannus****. It [the pannus] receded and they were able to rest."*[202]

Another example relates to the treatment of epilepsy:

"*I say: A sternutatory (saʿut) [a substance provoking sneezing] that is excellent for epilepsy;* ***a group was cured by it (buri'a 'alaihi jamaʿatun)****. Let the patient take a sternutatory made with sneezewort, white hellebore, cyclamen, and colocynth pith."*[203]

In both these examples, al-Razi remarks that a group of patients was positively affected by treatments that he had recommended.

3.2. Quantifying treatment success

Elsewhere, in Doubts about Galen, al-Razi reports the proportions of groups of patients who were treated successfully.

One such quotation concerns a condition called 'drum-like dropsy', a type of dropsy in which the lower abdomen is so swollen that it sounds like a drum on percussion. Galen said that when certain intestinal pains are located around the navel

[202] Al-Razi,(c.865–925), *Al-Kitab al-Hawi fi l-Tibb*. Osmania Oriental Publications Bureau, Hyderabad. Quoted in Pormann, P.E. (2013).
[203] Ibid

or the small of the back, this sometimes resulted in drum-like dropsy. Al-Razi only partially agrees with Galen here, saying:

"I have seen this more than once in the hospitals (bimaristanat) in Iraq, and in my home in Rayy. In some of them [the patients], drum-like dropsy followed, but in others strangury, and in yet others a pain in the hip. Since I noticed this many times, whilst neither purging nor warm drugs that expel wind were of any help for them, I applied myself to giving them enemas that provide heat and fatten the region of the kidneys. I made them sit in warm sand up to their chest. I made some of them constantly attend dry baths [i.e. hot rooms with little moisture]. ***Three were cured whilst one was affected by dropsy more quickly than those who were not treated (Buri'a minhum thalathatu nafarin wa-asra'a l-istisqa'u ila nafarin asra'a mimman lam yu'alaj),*** *but by a lighter [variety of dropsy]. I did not, however, see that anyone recovered from 'drum-like' dropsy[204]."*

In other words, according to al-Razi, the type of pain described by Galen only sometimes resulted in drum-like dropsy. In any case, al-Razi wanted to prevent this dropsy from occurring and he devised a way of lessening the possibility. When commenting on the effectiveness of this method, al-Razi resorts to crude statistics — three were cured, whereas one contracted a lighter variety of dropsy — which we must assume was not fatal, as drum-like dropsy was[205].

Another example concerns a more impressive numerator and denominator.

*"A careful intellectual ought not to desire in this method the utmost certainty, and ought not to rely on it [the method] and make absolute statements on prognoses or deduce the treatment and regimen in accordance with it [the method]. For there were approximately three hundred out of two thousand patients (**wa-qad***

[204]Al-Razi,(c.865–925), *Al-Shukuk 'ala Jalinus,* Quoted in Pormann, P.E. (2013)
[205]Pormann, P.E. (2013)

kanu ʿala thalathati mi'atin min nahwi alfay maridin*) whose state developed in a contrary fashion. I therefore refrained from announcing what was happening except where the patient's situation was clearly and strongly indicated, so that I could have no doubt about it. For a time I continued seeking through experience [tajriba] and reason [qiyas] a new regimen for acute diseases in which I could be sure to avoid any mistake which would affect the patient—my only fault being my inability to find a speedy cure—until I found it".*[206]

Al-Razi does not make clear for which condition he is seeking a new treatment, apart from the fact that it is acute. Only the hospital environment could provide such large numbers ('two thousand') and thus make it possible for al-Razi to seek out new cures, or, to put it in more modern terms, to conduct medical research[207].

3.3. Qualifying medical experience

Galen observed that one cannot rely on any and all experience: one needs to make sure that experience meets certain standards. He also insisted that the individual nature of a patient—what many physicians call idiosyncrasy – cannot be grasped. Although al-Razi fervently believed in the importance of experience, he also used the first Hippocratic aphorism to warn that 'experience is dangerous'. As illustrated in the text referring to 2000 patients, however, al-Razi makes an epistemologically more astute point: the physician should be aware that complete certainty cannot be attained in medicine, perhaps especially when dealing with acute diseases. Two centuries after al-Razi, Abd al-Latif al-Baghdadi reminded his readers, that medicine is the 'knowledge of probabilities', and that this requires conjecture according to the rules of the art of medicine[208].

[206]Al-Razi,(c.865–925), *Al-Shukuk ʿala Jalinus,*Quoted inPormann, P.E. (2013)
[207]Pormann, P.E. (2013)
[208]Ibid

Abd al-Latif al-Baghdadi was born in March 1162 in his grandfather's house in a street called Darb al-Faludhaj in Baghdad. He died there on 9 November 1231. Here we concentrate on the treatise the *Book of the Two Pieces of Advice.* This book was probably written in Aleppo, Syria, during the years 1216–21, but may have been composed in the Anatolian city of Erzinjan sometime during the 1220s. It is an extensive diatribe directed against 'false knowledge', which, according to Abd al-Latif, was even worse than ignorance. As the title suggests, the book is divided into 'two pieces of advice': 'advice' for would-be physicians, and 'advice' for would-be philosophers. Both incur Abd al-Latif's scathing criticism and find themselves lambasted in no uncertain terms[209].

[209]Joosse, N.P and Pormann, P.E (2008). Archery, mathematics, and conceptualizing inaccuracies in medicine in 13th century Iraq and Syria. *JLL Bulletin: Commentaries on the history of treatment evaluation (https://www.jameslindlibrary.org/articles/archery-mathematics-and-conceptualising-inaccuracies-in-medicine-in-13th-century-iraq-and-syria/)*

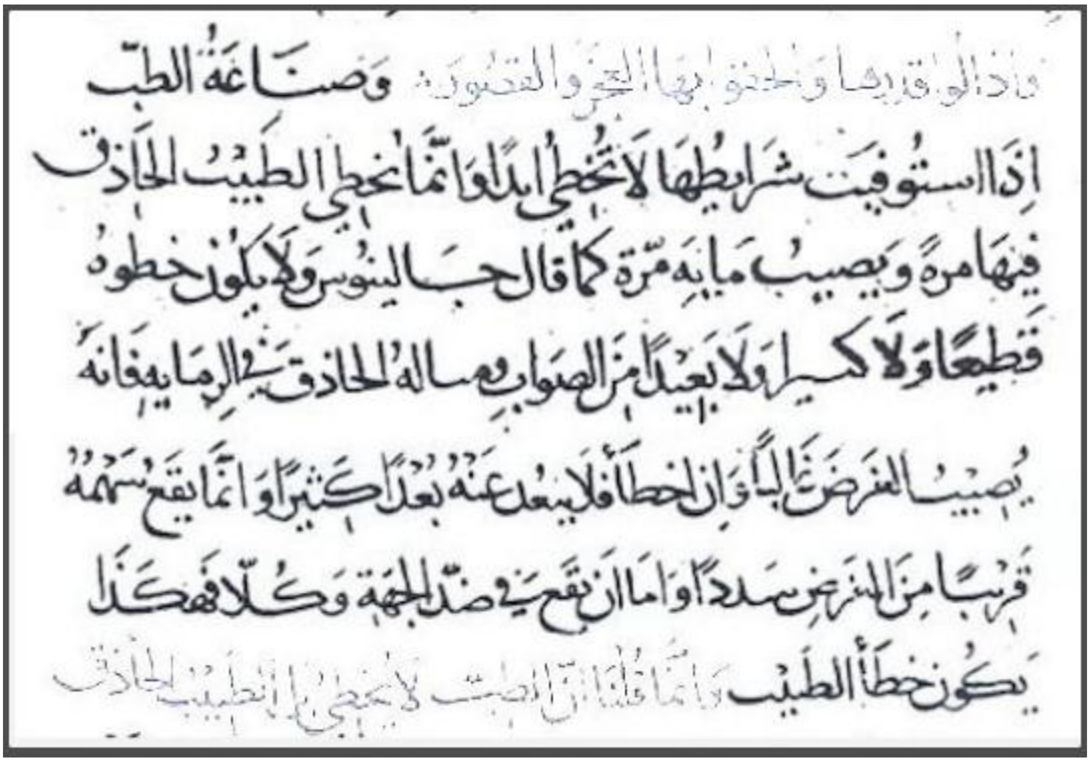
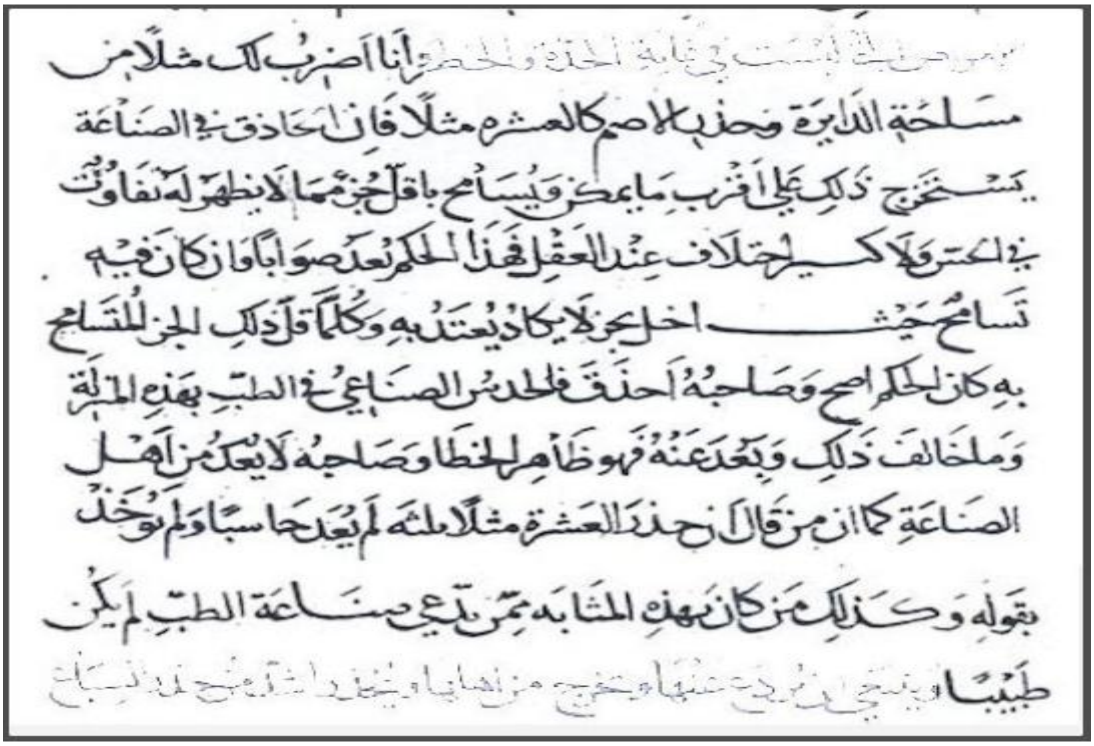

وصناعة الطب
إذا استوفيت شرائطها لا تخطئ أبداً وإنما يخطئ الطبيب الحاذق
فيها مرة ويصيب مائة مرة كما قال جالينوس ولا يكون خطؤه
قطعياً ولا كبيراً ولا بعيداً من الصواب ومثاله الحاذق في الرماية فإنه
يصيب الغرض غالباً وإن أخطأ فلا يبعد عنه بعداً كثيراً وإنما يقع سهمه
قريباً من الغرض جداً وأما أن يقع في ضد الجهة وكلا فهكذا
يكون خطأ الطبيب

Figure 4: Al-Baghdadi,(c.1216-1221),The Book of the Two Pieces of Advice by Abd al-Latif, the son of Yusuf, to the General Public (Kitab al-Nasihatain min Abd al-Latif b. Yusuf ila l-nas kaffatan).

Translation

"When the conditions (shurut) of the medical art are fully adhered to, then it never makes a mistake. The intelligent physician only errs occasionally, but gets things right a hundred times, as Galen said. Moreover, his mistake will be neither decisive nor great nor far from what is correct. One can compare him to an expert in archery who mostly hits the mark, and when he misses then it (i.e., his arrow) will not be far off, but it will rather land near [the target]. But in the event of the arrow falling entirely in the opposite direction, then [this is like] a physician committing an error."[210]

[210] Al-Baghdadi,(1216–21), *The Book of the Two Pieces of Advice by Abd al-Latif, the son of Yusuf, to the General Public (Kitab al-Nasihatain min Abd al-Latif b. Yusuf ila l-nas kaffatan*). Bursa: MS Hüseyin Çelebi 823, item number 5; medical section on fol. 62a-78a; philosophical section: fol. 78b-100b. Translated by Peter Joosse and Peter Pormann



أنا أضرب لك مثلاً من
مساحة الدائرة وجذر الاصم كالعشرة مثلاً فإن الحاذق في الصناعة
يستخرج ذلك على أقرب ما يمكن ويسامح بأقل جزء مما لا يظهر له تفاوت
في الحس ولا كبير اختلاف عند العقل فهذا الحكم نعده صواباً وإن كان فيه
تسامح حيث لا يخل بجزء لا يكاد يعتد به وكلما قل ذلك الجزء المتسامح
به كان الحكم أصح وصاحبه أحذق فالحدس الصناعي في الطب بهذه المنزلة
وما خالف ذلك وبعد عنه فهو ظاهر الخطأ وصاحبه لا يعد من أهل
الصناعة كما أن من قال إن جذر العشرة مثلاً ثلاثة لم يعد حاسباً ولم يؤخذ
بقوله وكذلك من كان بهذه المثابة ممن يدعي صناعة الطب لم يكن
طبيباً

Figure 5: Al-Baghdadi,(c.1216-1221),The Book of the Two Pieces of Advice by Abd al-Latif, the son of Yusuf, to the General Public (Kitab al-Nasihatain min Abd al-Latif b. Yusuf ila l-nas kaffatan).

Translation

"I shall give you as an example the surface of the circle or a square root such as that of [the number] ten. Someone skilled in this art determines this (irrational number) as closely as possible, and will tolerate (only) the smallest part (of error), the difference of which is not apparent to sense-perception; however, it is not equivalent to a small difference for the intellect (that is, the error cannot be perceived by the eye, but by the intellect). Such a solution is deemed to be correct, even if a certain tolerance is present in it, provided that it does not exceed a part (that is, an amount) which basically does not count. As long as the part which one tolerates (that is, the margin of error) is small, the solution is quite correct, and the person arriving at it is quite skilled. Therefore, artful conjecturing in medicine is similar. Yet what is different to this (small amount of error) is evidently an error, and those who commit it are not

deemed to belong to those exercising the art (of medicine). Likewise, if someone says that the square root of ten is three, he cannot be counted as an arithmetician, and his words cannot be accepted. This is also valid for those who are in the same situation, namely those who claim to master the art of medicine without (actually) being a physician."[211]

Abd al-Latif makes the point that, insofar as medicine is an art (*sina'a*, Greek: *techne*) concerned with universals, it does not make mistakes. Rather, it is individual practitioners of this art, physicians, who inevitably make mistakes, since they are concerned with particulars; and particulars are by nature imprecise and prone to variation. To put it differently, medicine can correctly describe general principals, although concrete, individual practitioners will still, of necessity, make mistakes when applying them. The fault does not lie with medicine as such, but (a) with the particular circumstances which may be too complex to be fully encompassed by general principals; and (b) with the practitioner himself, who, as an individual human being, makes mistakes[212].

Abd al-Latif adduces these examples to illustrate that, in this respect, medicine resembles mathematics. Sometimes one can only give an approximation, and the competent mathematician, like the good physician, will arrive at a fairly good approximation, whilst incompetent ones will be far off the mark, to use Abd al-Latif's earlier image. Thus inaccuracies in mathematics are compared to inaccuracies in medicine[213].

[211]Al-Baghdadi,(1216–21), *The Book of the Two Pieces of Advice by Abd al-Latif, the son of Yusuf, to the General Public (Kitab al-Nasihatain min Abd al-Latif b. Yusuf ila l-nas kaffatan*). Bursa: MS Hüseyin Çelebi 823, item number 5; medical section on fol. ; philosophical section: fol. 64a14–65a178b-100b. Translated by Peter Joosse and Peter Pormann.

[212] Joosse NP, Pormann PE (2008)

[213]Ibid

4. Clinical therapeutic trials

Al-Razi’s willingness to test the validity of therapeutic claims and theories in practice is illustrated in another passage in Kitab al-Hawi[214]. He recognized the symptom complex that heralded the onset of meningitis – dullness and pain in the head and neck, the avoidance of bright light (photophobia), insomnia and exhaustion – and wondered how best to treat these patients:

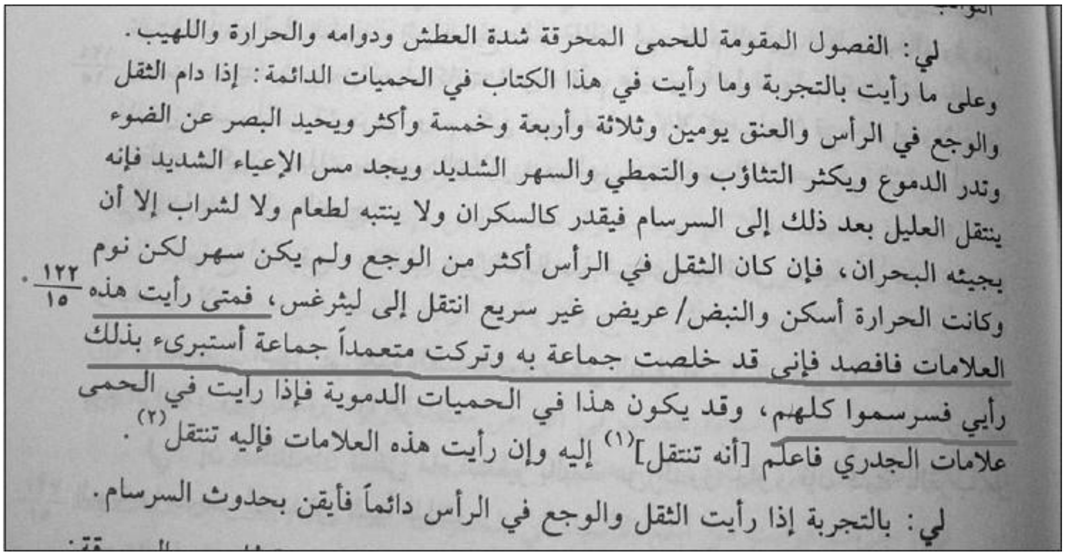

لي: الفصول المقومة للحمى المحرقة شدة العطش ودوامه والحرارة واللهيب.
وعلى ما رأيت بالتجربة وما رأيت في هذا الكتاب في الحميات الدائمة: إذا دام الثقل
والوجع في الرأس والعنق يومين وثلاثة وأربعة وخمسة وأكثر ويحيد البصر عن الضوء
وتدر الدموع ويكثر التثاؤب والتمطي والسهر الشديد ويجد مس الإعياء الشديد فإنه
ينتقل العليل بعد ذلك إلى السرسام فيقدر كالسكران ولا ينتبه لطعام ولا لشراب إلا أن
بجيئه البحران، فإن كان الثقل في الرأس أكثر من الوجع ولم يكن سهر لكن نوم
وكانت الحرارة أسكن والنبض/ عريض غير سريع انتقل إلى ليثرغس، فمتى رأيت هذه ١٢٢/١٥
العلامات فافصد فإني قد خلصت جماعة به وتركت متعمداً جماعة أستبرىء بذلك
رأيي فسرسموا كلهم، وقد يكون هذا في الحميات الدموية فإذا رأيت في الحمى
علامات الجدري فاعلم [أنه تنتقل](١) إليه وإن رأيت هذه العلامات فإليه تنتقل(٢).
لي: بالتجربة إذا رأيت الثقل والوجع في الرأس دائماً فأيقن بحدوث السرسام.

Figure 6: Al-Razi (c.854-925), Al-Hawi (Liber Continens), Part of page 2297, volume 15 with added underlining to highlight relevant text.

“*So whenever you see these signs [prodromal signs and symptoms of meningitis], go for venesection for the reason that I did save a group [of patients] by using it while deliberately leaving another in order to verify my point of view; they all [the second group] developed meningitis.*”[215]

[214] Iskandar, A.Z. (1962). *Ar-Razi, the clinical physician*. Al-Mashriq 56:217-282. [Translated into English by Zakia and Peter Pormann. *Life Sciences*, pp 217-251].

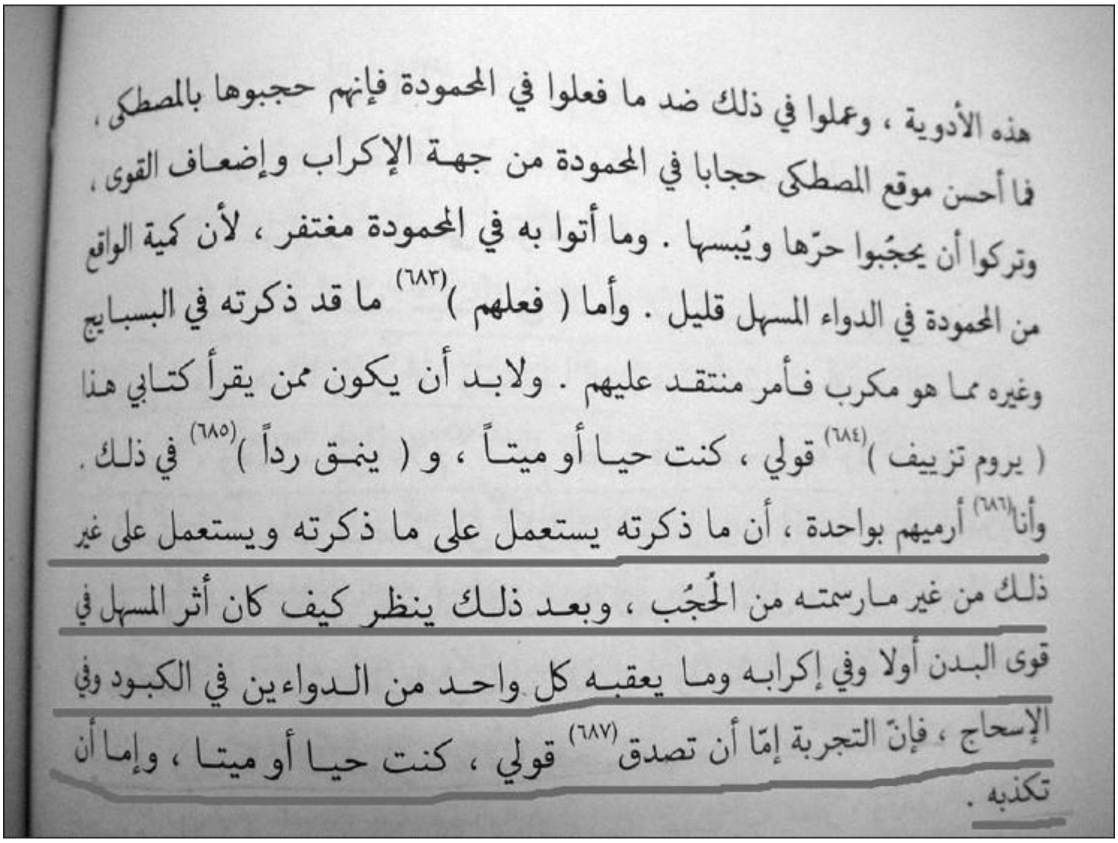
[215] Translated from: Al-Razi (Rhazes) Vol. 15. Beiurt Edition: Dar Al-Kutub Al-Elmeyyah; 2000. Kitab Al Hawi Fi Al-Tibb (Rhazes’ Liber Continens) p. 2297. Part 5, (corresponds to page 122, Volume 15 of the Hyderabad edition: Hyderabad: Dairatul Maarif Al-Osmania; 1961-1963)

Al-Razi clearly used a control group when trying to assess whether bloodletting is effective against brain fever. Although he does not offer a theoretical discussion highlighting the concept of the group, it is clear that he regarded numerical observation as important, and he mentions how different patient groups are affected differently by certain treatments. This theoretical concept of the patient group became so important in Europe from the seventeenth century onwards[216].

Al-Razi played a pioneering role in initiating the case-control method of experimentation in clinical medicine. Islamic scholars who came after him followed and developed the same scientific method.

Ibn-Zuhr (Avenzoar) is considered to be the most famous physician a century after Ibn-Sina. Some even praised him as the greatest physician since Galen. He was an advocate of the empirical basis for medicine and his works had a durable effect on drug experiments. Avenzoar underscored the importance of experimental versus theoretical reasoning in medical practice. In an interesting passage of his book *Al-Taysir fi al-Mudawat wa-'l-Tadbir* [Simplification Concerning Therapeutics and Diet] he mentioned:

[216]Tibi S (2005). Al-Razi and Islamic medicine in the 9th Century. *JLL Bulletin: Commentaries on the history of treatment evaluation (https://www.jameslindlibrary.org/articles/al-razi-and-islamic-medicine-in-the-9th-century/)* accessed in June 2020.



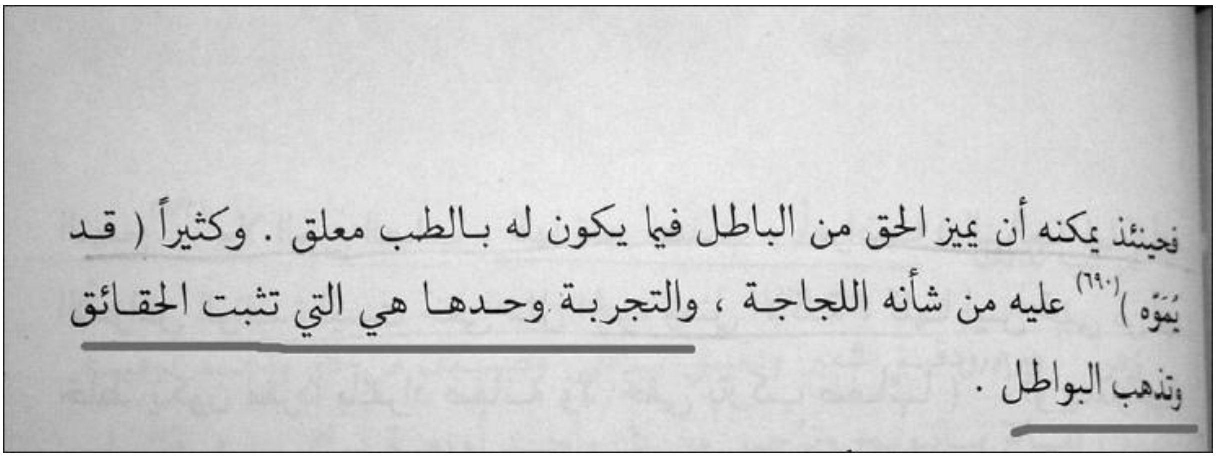
هذه الأدوية ، وعملوا في ذلك ضد ما فعلوا في المحمودة فإنهم حجبوها بالمصطكى ،
فما أحسن موقع المصطكى حجابا في المحمودة من جهة الإكراب وإضعاف القوى ،
وتركوا أن يحجُبوا حرّها ويُبسها . وما أتوا به في المحمودة مغتفر ، لأن كمية الواقع
من المحمودة في الدواء المسهل قليل . وأما (فعلهم)[٦٨٣] ما قد ذكرته في البسبايج
وغيره مما هو مكرب فأمر منتقد عليهم . ولابد أن يكون ممن يقرأ كتابي هذا
(يروم تزييف)[٦٨٤] قولي ، كنت حيا أو ميتاً ، و (ينمق رداً)[٦٨٥] في ذلك .
وأنا[٦٨٦] أرميهم بواحدة ، أن ما ذكرته يستعمل على ما ذكرته ويستعمل على غير
ذلك من غير ممارسته من الحُجُب ، وبعد ذلك ينظر كيف كان أثر المسهل في
قوى البدن أولا وفي إكرابه وما يعقبه كل واحد من الدواءين في الكبود وفي
الإسحاج ، فإنّ التجربة إمّا أن تصدق[٦٨٧] قولي ، كنت حيا أو ميتا ، وإما أن
تكذبه .

Figure 7: Ibn Zuhr (c.1074-1091) Al-Taysir fi al-Mudawat wa-'l-Tadbir, Part of page 326 with added underlining to highlight relevant text.

"*It is bound to happen, whether I am still alive or dead, that some of the readers of my book will aim at misrepresenting my opinions [on laxatives and how to counteract its side effects]. Hence, they may compose a refutation for that purpose. Then I will challenge them to one [contest]: let them utilize the medicines I mentioned in the same way I prescribed and utilize it in a different way. Then, the effects and side effects of each method are to be recorded. Certainly the experiment will either validate or invalidate my opinion whether I was then alive or dead.*"[217]

[217] Al-Khoori M, (1983)(ed.)Kitab Al-Taisir Fi Al-Mudawat Wa Al-Tadbeer. Translated from: Ibn Zuhr. (1st ed);1 and 2:326–7.

Ibn Zuhr, then, elaborated on how experimentation is far more accurate and reliable than syllogism in finding truth and providing evidence. He concluded by emphasizing that, "*Experimentation is the only way to prove truth and dismiss fallacy*"[218]



فحينئذ يمكنه أن يميز الحق من الباطل فيما يكون له بالطب معلق . وكثيراً (قد
يموّه)(٦٩٠) عليه من شأنه اللجاجة ، والتجربة وحدها هي التي تثبت الحقائق
وتذهب البواطل .

Figure 8: Ibn Zuhr (c.1074-1091), Al-Taysir fi al-Mudawat wa-'l-Tadbir Part of page 327 with added underlining to highlight relevant text.

5. Drug potency trials

The second book (*kitab*) of Ibn Sina's *Canon* is assigned to simple basic drugs (*Al-Adwiyah Al-Mufrada*). In the second chapter (*maqala*) of its first section (*jumla*) titled "*On testing for the potency of drugs through experimentation* (*tajriba*)", Ibn Sina states the following:

[218] Al-Khoori M, (1983)(ed.)Kitab Al-Taisir Fi Al-Mudawat Wa Al-Tadbeer. Translated from: Ibn Zuhr. (1st ed);1 and 2:326–7.

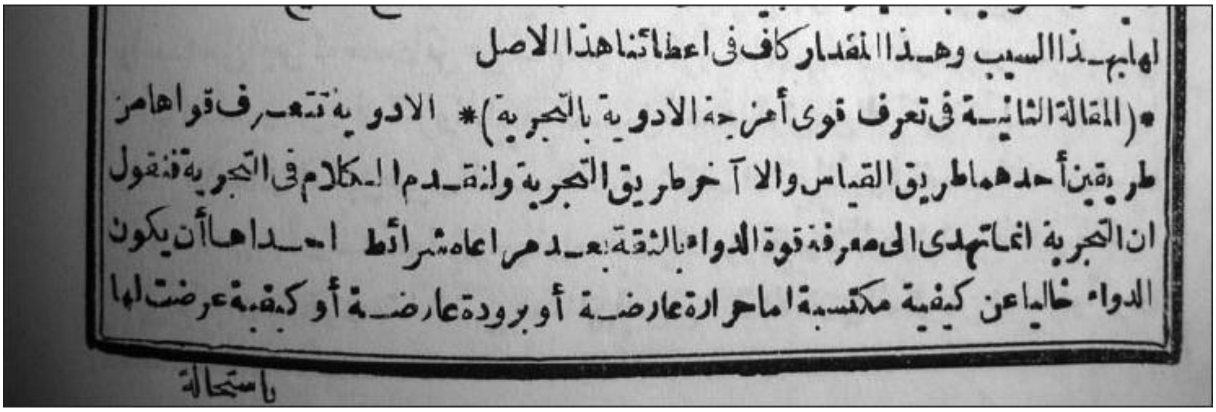

اهابه ذا السبب وهذا المقدار كاف في اعطائنا هذا الاصل
(المقالة الثانية في تعرف قوى أمزجة الادوية بالتجربة) * الادوية تتعرف قواها من
طريقين أحدهما طريق القياس والآخر طريق التجربة ولنقدم الكلام في التجربة فنقول
ان التجربة انما تهدي الى معرفة قوة الدواء بالثقة بعد مراعاة شرائط احداها أن يكون
الدواء خاليا عن كيفية مكتسبة اما حرارة عارضة أو برودة عارضة أو كيفية عرضت لها
باستحالة

Figure 9: Ibn Sina, (c.980-1037) Part of page 224, vol. 2, of Kitab al-Qanun fi al-Tibb (The Canon of Medicine)

"*The potency of drugs' nature* (*amzija*) *can be identified in two ways, one of them is analogy* (*qiyas*) *the other is by way of experimentation* (*tajriba*). *And let us start with discussing experimentation. So, we say that experimenting leads to confident knowledge of the potency of the medicine after taking into consideration certain conditions.*"[219]

Ibn Sina, then, specified seven rules that need to be taken into account while performing the drug-testing experiment. He discussed in details the importance of each prerequisite emphasizing the need to know them all:

"1. The drug must be free from any acquired quality: this can occur if the drug is exposed to temporary heat or cold, if there is a change in the essence of the drug, or if the drug is in close proximity to another substance. Water, although cold by nature, will give warmth as long as it is heated; euphorbium, although hot by nature, will have a cold effect when cold; almond, although naturally neutral, will have a strong effect of heat if it turns rancid; and fish, although cold, is a strong source of heat if salt is added to it.

[219]Translated from: Ibn Sina Vol. 1. Cairo: Bulaq; 1877. Kitab Al-Qanum Fi Al-Tibb (The Canon of Medicine) p. 224. Undated Reprint by Dar Sadir.

2. The experiment must be done on a single, not a composite, condition. In the latter case, if the condition consists of two opposite diseases and the drug is tried and found beneficial in both, we cannot infer the real cause of the cure. Example: if we treat a patient suffering from phlegmatic fever with agaric and the fever abates, this does not mean that because it was useful for a hot illness agaric *possesses the property of coldness. It is possible that the drug was effective because it dissolved the phlegm or removed it; when the [phlegm] disappeared the fever disappeared. This action represents both the direct and the accidental benefit of the drug. The direct benefit relates to the [phlegm], and the indirect refers to the fever."*

Ibn Sina makes clear here that he realizes that if a patient suffering from more than one disease recovers after receiving a drug, one cannot infer that the treatment was the reason for the recovery. A treatment should be tested in a controlled environment to reduce confounding factors, in this case, by excluding patients with complex, multiple illnesses.

In the third rule, Ibn Sina stresses that a drug can affect the disease itself directly, and thus cure it, but that it can also have a secondary, accidental effect, and that it would then cure a symptom only, without removing the cause of the problem[220].

"3.The drug must be tested on two contrary conditions. If it is effective on both, we cannot judge which condition benefited directly from the drug. It is possible that the drug acted directly against one disease, and acted against the symptom of the other. Scammony, if used to treat a cold disease, would no doubt have a warming effect and bring benefit. If we try it on a hot disease, such as diurnal fever, it would

[220]Nasser, M. and Tibi A. and Savage-Smith, E. (2007). Ibn Sina's Canon of Medicine: 11th century rules for assessing the effects of drugs. *JLL Bulletin: Commentaries on the history of treatment evaluation (https://www.jameslindlibrary.org/articles/ibn-sinas-canon-of-medicine-11th-century-rules-for-assessing-the-effects-of-drugs/)* accessed in June 2020.

also have a beneficial effect because it gets rid of yellow bile. In these cases, an experiment would be of no help in deciding whether [the drug] is hot or cold, unless we could know that it acted directly on one disease and acted on a symptom of the other.

4. The potency of the drug should be equal to the strength of the disease. If some of the drugs are inadequate with regard to heat when compared to the coldness of an illness, they will not be able to effect a cure. Sometimes during their application against coldness, their function for producing warmth is weakened. So it is best to experiment first using the weakest [dosage] and then increase it gradually until you know the potency of the drug, leaving no room for doubt.

5. One should consider the time needed for the drug to take effect. If the drug has an immediate effect, this shows that it has acted against the disease itself. If its initial effect is contrary to what comes later, or if there is no initial effect at first and the effect shows up later, this leads to uncertainty and confusion. Actions in such cases could be accidental: their effect is hidden at first and later comes into the open. The confusion and uncertainty relate to the potency of the drug.

6. The effect of the drug should be the same in all cases or, at least, in most. If that is not the case, the effect is then accidental, because things that occur naturally are always or mostly consistent.

7. Experiments should be carried out on the human body. If the experiment is carried out on the bodies of [other animals] it is possible that it might fail for two reasons: the medicine might be hot compared to the human body and be cold compared to the lion's body or the horse's body…The second reason is that the quality of the medicine might mean that it would affect the human body differently from the animal body…

...These are the rules that must be observed in finding out the potency of medicines through experimentation. Take note!"[221]

That chapter is a landmark in the development of the scientific method for testing of drugs and is remarkably consistent with modern concepts.

6. Experimentation on animals

6.1. To test safety of drugs

The first recorded account of animal experimentation on the toxicity of medicines comes from Al-Razi in the 9th century who is known to have given monkeys doses of mercury to test its safety for human use as documented by the 13th century Ibn Al-Baytar in his book *Al-Jami' Li-Mufradat al-Adwiya wa-'l-Aghdiya* (Complete Book of Simple Medicaments and Diet).[222]

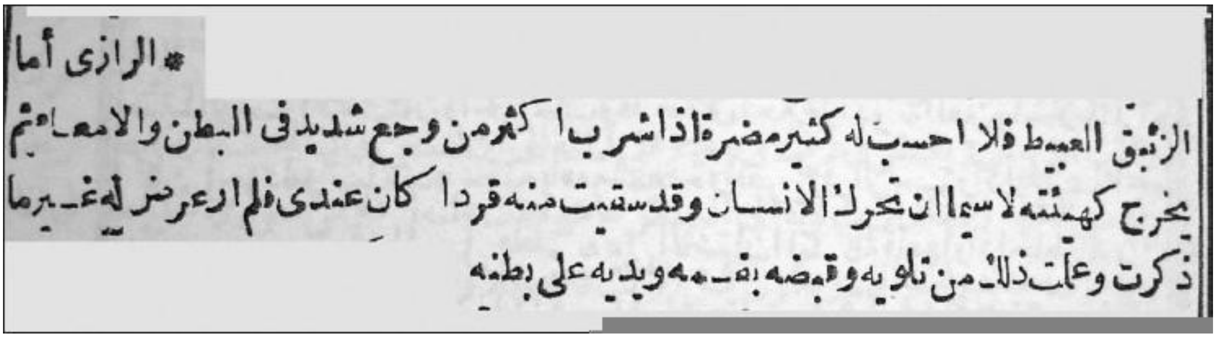

* الرازى أما
الزيبق العبيط فلا احسب له كثير مضرة اذا شرب اكثر من وجع شديد فى البطن والامعاء ثم
يخرج كهيئته لاسيما ان تحرك الانسان وقد سقيت منه قردا كان عندى فلم ار عرض له غير ما
ذكرت وعلامات ذلك من تلويه وقبضه بفمه ويديه على بطنه

Figure 10: Ibn Al-Baytar, (c.1197-1248) Al-Jami' Li-Mufradat al-Adwiya wa-'l-Aghdiya (Complete Book of Simple Medicaments and Nutritious Items) Part of page 178, vol. 2

[221]Ibn Sina, (c.980-1037) *Al-Qanun Fi Al-Tibb (The Canon of Medicine)*Translation by Aida Tibi and Emily Savage-Smith

[222] Ibn Al-Baytar, (c.1197-1248) *Al-Jamie Limufradat Al-Adwiya Wal-Aghdiya (Complete Book of Simple Medicaments and Nutritious Items)* Vol. 2. Cairo, Baghdad: Al Matbaa Al Ameereyya Al Masreyya 1291 H, 1874AD. Undated Offset edition: Al-Muthana Bookshop; p. 178.

Teachings of famous medieval physicians such as Rhazes and Avicenna had a durable effect on the succeeding generations of Muslim physicians. One of the most famous physicians six centuries after Avicenna (circa. 1690) was Muhammad Hussayn ibn Muhammad Hadi al-Aghili al-Alavi al-Khurasani al-Shirazi. He refined the criteria of Avicenna on drug experiments and in his famous book, Makhzan Al-Adwiah (The Treasury of Drugs), mentioned the same rules of Ibn Sina[223].

Aghili Khorasani mentioned that:

"As the experiment is very dangerous, and can lead to death in the case of negligence or without taking into consideration the conditions, [drugs] should be examined in animals with similar temperaments such as monkeys. And the animals should be kept for three days [to watch out] for side effects".[224]

This reminds us of preclinical stage of drug trials (animal studies).

6.2. <u>To test the safety of surgical procedures</u>

The role of tracheotomy in the resuscitation of life-threatening suffocation due to upper airway obstruction remained controversial for several centuries. This state of affairs lasted until the Islamic era when Al-Razi and later Ibn Sina spoke favourably of the operation and refined the technique[225].

Al-Zahrawi, in his book *Al-Tasrif Li-man 'Ajaza 'An al-Ta'lif* (The Disposal of Medical Knowledge to He Who is not Able to Get it by Himself From The Other Compilations) reported from his own experience the successful management of a suicidal cut wound of the trachea and concluded that tracheotomy is not a dangerous procedure. However, controversy continued in the time of Ibn Zuhr who reports in *Al-Taysir* that he has not seen the operation done. Accordingly, in order to find out the

[223]Zarvandi, M. and Sadeghi, R.(2019)

[224]Khorasani A.(2010)*Makhzan-Al-Adviah [The treasury of drugs]*. 2nd ed. Tehran: Tehran University of Medical Sciences Press, 2010, p. 25.

[225]Rabie, A.H.(2011)

truth about the safety of this surgical procedure, he decided to do the experiment explained in the following excerpt from his book *Al-Taysir*:

"*Earlier on in my training when I read those opinions (controversies), I cut on the lung pipe (wind pipe, trachea) of a goat after incising the skin and the covering sheath underneath. Then I completely cut off the substance of the pipe an area just less than the size of a tirmisa (lupine seed). Then I kept washing the wound with water and honey till it healed and it (the animal) totally recovered and lived long time*."[226]

This unique experiment represents a further step in the development of the experimental school started by Al-Razi. Ibn Zuhr's application of an experimental model to a clinical problem was the first ever reported use of experimental surgery. It was the forerunner of the method by which many current surgical procedures were developed. The authors who came after Al-Zahrawi and Ibn Zuhr such as Muhdhdhab al-Din Al-Bagdadi and Ibn al-Quff (1232-1286 CE) recommended tracheotomy unreservedly in life-threatening upper airway obstruction not relieved by other means, and described the technique with more refinements and in more detail[227].

7. Dissection and dissection experiments

We have shown that Al-Razi, Ibn Sina, Muhadhdhab al Din Al-Baghdadi and Ibn Zuhr, emphasized the value of dissection and knowledge of anatomy in medical education and practice. Also a similar view was held by the 13th century Islamic physician Ibn al-Nafis, the discoverer of the coronary and pulmonary circulations, in his book *Sharh Tashrih al-Qanun*. Furthermore, the presence of anatomical drawings within the textbooks authored by the Islamic scholars is a trend that started and

[226]Al-Khoori M. Translated from: Ibn Zuhr (Avenzoar) 1st ed. 1 and 2. Damascus: Darul Fikr Press for the Arab Educational Scientific and Cultural Organization; 1983. Kitab Al-Taisir Fi Al-Mudawat Wa Al-Tadbeer; p. 149.
[227]Rabie, A.H.(2011)

flourished in the Islamic era reflecting the role of direct observations and experience in dissection. Therefore, contrary to the generally accepted current impression, the interest and practical experience of medieval Islamic scholars in the study of anatomy led them to contribute to the advance of this important medical science, by correcting many of Galen's erroneous anatomical concepts[228].

The following translated quotations from *Sharh Tashrih al-Qanun* are some other examples of how Ibn Al-Nafis, using his own anatomical observations, disproved other Galenic doctrines which were taken for granted for several hundred years:

- "*As regard his statement (the statement of Galen accepted by Ibn Sina) that the heart has 3 ventricles: this cannot be correct because the heart has only 2 ventricles. Indeed dissection disproves what they said.*"[229]
- "*Galen's attribution of the nourishment of the heart to the blood in the right ventricle can never be accepted as true, because the nourishment of the heart is actually from the blood passing to it in the vessels situated in its substance.*"[230]

The reliance of medieval Islamic scholars on experimentation for the verification of knowledge is further demonstrated in *Kitab al-Ifada wa al-I'tibar* (Book of Utility and Reflection) by Muwaffaq al-Din 'Abd al-Latif Al-Baghdadi (1162-1231 CE).

In 1200 AD, a terrible famine ravished Egypt and killed thousands of people. Al-Baghdadi seized the opportunity and examined a large number of skeletons. His account is one of the earliest recorded post-mortem autopsies in the history of medicine. Interestingly, he mentioned that accounts of Galen were wrong for the

[228]Rabie, A.H.(2011)
[229]Ibn Al-Nafis, (c. 1213-1288) *Kitab Sharh Tashreeh al-Qanon*. Translated aand edited by Qattaya S. (1988) Cairo: The Supreme Council for Culture and the Egyptian Book Bureau Manuscript Editing Centre; p. 388.
[230]Ibn Al-Nafis, (c. 1213-1288) p. 389.

mandible and sacrum. His work was influential and showed the importance of founding medical knowledge on empiricism[231].

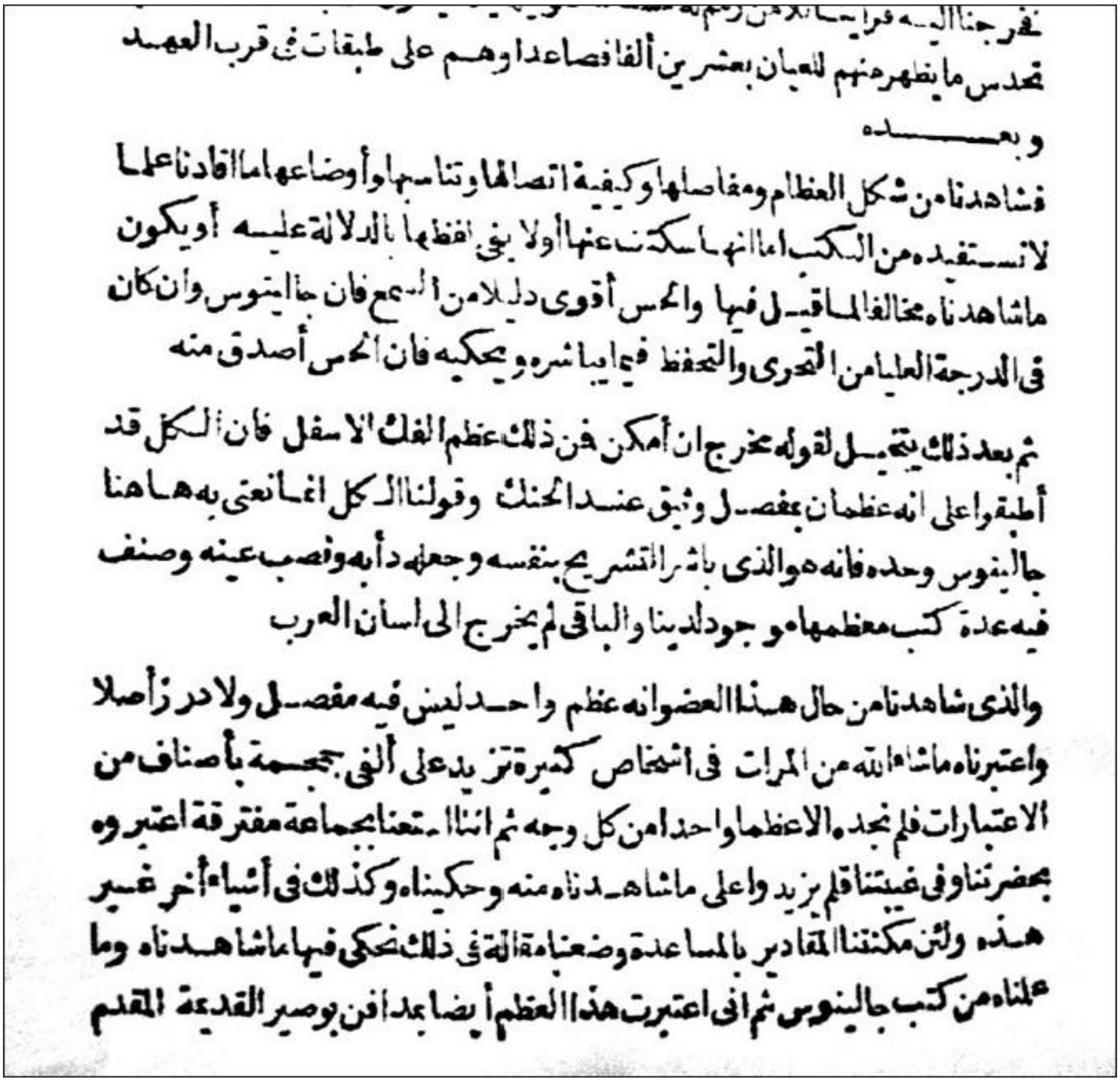
The following translation from his Book of Utility and Reflection

"*So with regard to the shape, proportion and relations of bones and joints [in the large number of the examined human skeletons], we have gained knowledge that we could not obtain from books either because of being overlooked [by its authors] or because of lack of textual clarity or because our findings are different from what is written in those books. Indeed, direct observation is stronger evidence than hearing [what is written by others]. And although Galen was of the highest qualities in checking and verifying what he reports, direct observation is a more true [source of knowledge] than him. Then an attempt can be made, if possible, to think of an explanation for his views. Among those [discrepancies] is the lower jaw bone which all agreed to describe as consisting of two separate bones joined at the chin by a strong joint. And, at this point, when we say "all agreed" we actually mean Galen alone because he was the one who devotedly practiced dissection by himself and composed several books about it; most of those books are available to us but the rest are still not in Arabic.*

However, based on our own observations, this organ [mandible]is, first and foremost, one bone only without a joint or a symphysis. Using various methods of testing, we examined it repeatedly, as many times as willed by Allah, in many specimens whose number exceeded two thousand skulls; but from all aspects we did not find it except as a single bone. We also arranged the assistance of a separated group who examined it [the mandible] in our presence and then in our absence. They did not add anything to our observations and reporting"[232]

[231]Zarvandi, M. and Sadeghi, R.(2019)

[232]Translated from: Al-Baghdadi, Muwaffaq al-Din Abd al-Latif,(1281 H/1864 AD) ;. *Kitab al-ifadah wa-al-ietibar: Fi al-umur al-mushahadah wa-al-hawadith al-muaayanah bi-ard Misr: qissat al-majaºah al-kubrá bi-Misr aam 600H*, Cairo: Wadi Al Neel Press



تحدس ما يظهر منهم للعيان بعشرين ألفا فصاعدا وهم على طبقات في قرب العهد
وبعده
فشاهدنا من شكل العظام ومفاصلها وكيفية اتصالها وتناسبها وأوضاعها ما أفادنا علما
لا نستفيده من الكتب اما انها سكتت عنها أو لا يفي لفظها بالدلالة عليه أو يكون
ما شاهدناه مخالفا لما قيل فيها والحس أقوى دليلا من السمع فان جالينوس وان كان
في الدرجة العليا من التحري والتحفظ فيما يباشره ويحكيه فان الحس أصدق منه
ثم بعد ذلك يتحيل لقوله مخرج ان أمكن فمن ذلك عظم الفك الأسفل فان الكل قد
أطبقوا على انه عظمان بمفصل وثيق عند الحنك وقولنا الكل انما نعني به ههنا
جالينوس وحده فانه هو الذي باشر التشريح بنفسه وجعله دأبه ونصب عينه وصنف
فيه عدة كتب معظمها موجود لدينا والباقي لم يخرج الى لسان العرب
والذي شاهدناه من حال هذا العضو انه عظم واحد ليس فيه مفصل ولا درز أصلا
واعتبرناه ما شاء الله من المرات في أشخاص كثيرة تزيد على ألفي جمجمة بأصناف من
الاعتبارات فلم نجده الا عظما واحدا من كل وجه ثم اننا استعنا بجماعة متفرقة اعتبروه
بحضرتنا وفي غيبتنا فلم يزيدوا على ما شاهدناه منه وحكيناه وكذلك في أشياء أخر غير
هذه ولئن مكنتنا المقادير بالمساعدة وضعنا مقالة في ذلك نحكي فيها ما شاهدناه وما
علمناه من كتب جالينوس ثم اني اعتبرت هذا العظم أيضا بمدافن بوصير القديمة المقدم

Figure 11: Al-Baghdadi (c.1281), Kitab al-Ifada wa-'l-I'tibar (Book of Utility and Reflection). Part of page 61

This unique anatomical experiment is another vivid documentation of the scientific mentality and experimental methodology of the scholars during the Islamic era. The large number of the examined specimens also reflects their awareness of the statistical importance of the sample size in determining the significance of findings. Moreover, in order to avoid any possibility of bias, Muwaffaq al-Din Al-Baghdadi repeated his experiment three times; first on his own, then together with a group of scholars and finally by another group of scholars on their own. To achieve accuracy of results, he also utilized more than one method of testing.[233]

[233]Zarvandi, M. and Sadeghi, R.(2019)

8. Post mortem examinations

8.1. On animals

The following translation from *Al-Taysir* of Ibn Zuhr shows how he used experimentation on animals in his search for evidence in the course of looking for a treatment for lung ulcerations:

"*Thus remedies for lung ulcerations are there around in the universe but are yet unknown to us. That is because sheep when caught with a lung disease do leave the herd and wander about as if looking for something; shepherds say for a plant to eat and when they finish eating it their illness is relieved completely and are back to normal. I did inspect lungs of sheep with the evident effect of breach of continuity and with obvious evidence of healing and union. Up till now I did not know that medicine and I do think no one before me knew it either.*"[234]

8.2. On human beings

Furthermore, Ibn Zuhr's description of the pericardial effusion in patients with serous pericarditis as "*looking like urine*"matches well with the current description of this fluid as "*straw colored*". This, also, indicates that he had seen and observed a collection of a fluid that could have never been obtained except by either pericardiocentesis or post-mortem examination. On the other hand, Ibn Zuhr's description of "*solid substances accumulating on the inside of the heart's covering looking like layers upon layers of membranes*"could not have been made possible without carrying out a post-mortem dissection. This is in line with the emphasis laid by his predecessors in the Islamic Era on the importance of a thorough knowledge of anatomy for both physicians and surgeons[235].

[234]Ibn Zuhr, (c.1061-1162), *Kitab Al-Taisir Fi Al-Mudawat Wa Al!-Tadbeer* , Al-Khoori M. (edi), Darul Fikr Press for the Arab Educational Scientific and Cultural Organization, Damascus
[235]Zarvandi, M. and Sadeghi, R.(2019)

9. Influence and recognition in the west

Muslim physicians, more particularly some of those who lived in Spain, contributed largely to the Renaissance in Europe. But in the matter of Muslim influence upon European medicine no names are greater than those of al-Razi and ibn Sina. Within a century and a half of the death of ibn Sina his works reached Spain and Sicily where they began to be translated. It was from these centres of learning that Arab science spread to the other parts of Europe. The spread of Arab science in the West was mainly due to the fact that the Eastern Caliphs were in constant touch with the rulers of Europe. The Pope was in control of all Europe so after the fall of Sicily and Toledo, he sent many clerics particularly to Toledo, so that it became a translation centre for Arabic works into Latin. These clerics came from different countries of Northern Europe to study there such as Herman the German, Adelard of Bath, Gerard of Cremona, Michael Scott, Robert of Chester, Vitelo, Moerbeke etc[236].

Harun al-Rashid sent an ambassador to the Court of the Roman Emperor. It is even said that Charlemagne came to Palestine incognito in order to consult the Arab physicians about his health. The medical scholars of the universities of Western Europe like Montpellier and Bologna particularly specialized in Arab learning and were responsible for the propagation of the teachings of al-Razi and ibn Sina. Montpellier had an immense library[237].

All the translations made by Constantine the African and Gerard of Cremona were housed in this library at a time when the Paris University library hardly contained more than a score of medical works. From these centers the teachings of the Arabs spread later on to all medical schools in Europe. From the sixth/twelfth to the eleventh/seventeenth century al-Razi and ibn Sina were considered superior even to Hippocrates and Galen[238].

[236]Sharif, (1963), p564
[237]Ibid
[238]Ibid

VII- Islamic philosophers: Roots of empiricism

The Muslim Caliphate, known for its great scientific advancements, was a particular civilization that made multiple contributions to the world's human knowledge and education. As Muhammad Saud expressed, "*Islam's greatest contribution to human history is its sound and healthy concept of God, and a sound and healthy vision of life and society*".[239]

1. From Al-Farabi to Ibn Bâjja : Organization of the Sciences

The Greek-Arabic sciences penetrated in the Islamic world during the 8th and 9th centuries AD due to the massive activity of translators, al-Kindi's vision of knowledge and also through the exegetical activity of the Aristotelian circle of Baghdad. From the end of the 10th, throughout the 11th, and up to the beginning of the 12th century, the production of original philosophical literature into Arabic and Persian became the main stream of the Arabic-Islamic philosophy, which was by then increasingly distant from the Greek sources in Arabic translation[240].

Aristotelian natural philosophy relies in part on sensory observation in its attribution of causal powers to natural bodies. So, it is not surprising that Arabic and Islamic thinkers raise objections to Aristotelian science, which anticipate later philosophical accounts of the problem of induction. Some of these emerge from within Aristotelianism[241].

[239]Saud, M. (1990), *The Scientific Method of Ibn al-Haytham*. Islamic Research Institute, Pakistan.
[240]Martini Bonadeo, Cecilia,(2019) "'Abd al-Latif al-Baghdadi", *The Stanford Encyclopedia of Philosophy* (Winter 2019 Edition), Edward N. Zalta (ed.), URL = <https://plato.stanford.edu/archives/win2019/entries/al-baghdadi/>. Accessed in June 2020.
[241]Richardson, Kara,(2015) "Causation in Arabic and Islamic Thought", *The Stanford Encyclopedia of Philosophy* (Winter 2015 Edition), Edward N. Zalta (ed.), URL = <https://plato.stanford.edu/archives/win2015/entries/arabic-islamic-causation/>. Accessed in June 2020.

Alfarabi is the author of a treatise "enumerating" the sciences and some books of the introductory genre: *Epistle with which the book on logic begins*, *Sections containing all what needs the beginner in logic*, and the *Book of the Isagoge or Introduction*. Alfarabi distinguished between syllogistic and non-syllogistic arts and aligned medicine, agriculture, carpentry with the second. They were non-syllogistic because, once their parts were assembled they resulted in doing something, not in employing a syllogism (*burhan*). He admitted, nevertheless, that some parts of these non-syllogistic arts were brought out by syllogisms, and he mentioned medicine, agriculture and navigation[242].

Philosophy in Al-Andalus developed later than in the East; it grew among Muslims and Jews, since both communities were nurtured by a common Arabic language. Abu Bakr Muhammad Ibn Yahyà ibn as-Sa'igh at-Tujibi Ibn Bâjja was known to the Latin philosophers as Avempace. We can assume that he was born in Saragossa around 1085. Ibn Bâjja followed other Andalusians philosophers in turning to Abu Nasr al-Farabi. Ibn Bâjja was not as systematic as Alfarabi but he picked up the forgotten non-syllogistic arts, changed them into "practical arts", and wrote:

"If some of them [the practical arts] employ syllogisms as medicine and agriculture do, they are not called syllogistic because their purpose is not [to convince another] nor to employ syllogisms, but to do some activity."[243]

Ibn Bâjja wrote that medical syllogisms have their premises specifically obtained by means of experience. Experience is obtained on its turn by means of perception through one's life time. Ibn Bâjja defines *tajriba,* experience:

[242] Montada, Josép Puig,(2018), "Ibn Bâjja [Avempace]", *The Stanford Encyclopedia of Philosophy* (Spring 2018 Edition), Edward N. Zalta (ed.), URL = <https://plato.stanford.edu/archives/spr2018/entries/ibn-bajja/>. Accessed in June 2020.
[243] Fakhry, M.(ed.)(1994)*Ta'aliq Ibn Bâjja 'alà mantiq al-Farabi*, Beirut, Dar al-Mashreq.

"As man's reliance on perception to know particular [aspects, juz'iyyat] of some matter so that some science results from this perception."[244]

Experience is said in general and in particular. If it is said in general, it points out that perception intents knowing particular [aspects] of a matter, from which a universal proposition results. The particular [instances] may take place either by man's will or naturally. Therefore, Ibn Bâjja ranks experience not as high in certitude as the first intelligible but second to it, and he makes it an essential part of medicine, insofar as it can yield universal propositions[245].

2.Ibn Sina on induction and experience

Avicenna provides a sustained critique of induction (*istiqrā'*) in his treatise *On Demonstration* (*al-Burhān*), the logical part of the *Book of Healing*. As he sees it, part of the problem is that induction may be supposed to lead to absolute, universal, and certain premises, while in reality it leads to merely probable belief. On the other hand, he holds that sensory observation together with a "hidden syllogism" gives rise to certitude. Avicenna elaborates this cognitive process under the heading of "experience" (*tajribah*). *Tajribah* is the Arabic translation of the Greek *empeiria*. Avicenna's account of experience is derived in part from remarks by Aristotle and al-Farabi on *empeiria*/*tajribah*, though it goes beyond these sources[246].

As Avicenna describes it, experience involves repeated sensation of some phenomenon that is preserved in memory, e.g., that purging of bile follows ingestion of scammony. It also involves a "hidden" or implicit process of reasoning. We infer that the repeated connection involves an essential relation between two things: e.g.,

[244]Montada, Josép Puig,(2018)
[245]Ibid
[246]Richardson, Kara,(2015)

it is not accidental that the purging of bile follows the ingestion of scammony, for regularities cannot be due to chance. This implicit process of reasoning removes doubt. So, experience gives rise to certitude. Avicenna defines certitude in terms of second-order belief: one is certain when one knows that what one has assented to cannot be otherwise. Certitude is not wholly subjective, since knowledge of a proposition requires its truth. On the other hand, though experience gives rise to certitude, it does not yield knowledge in the strict sense. For knowledge in the strict sense is both necessary *and* explanatory. From experience we derive our certitude *that* members of a certain species cause something; but experience does not show *why*.[247]

Avicenna also addresses the objection that experience may lead to false generalizations. He uses the following example. Suppose we had seen only black humans and had observed without exception that procreation issues in black children. By experience, we would conclude that all humans are black, i.e., that blackness is essential to humanity. In response to this objection, Avicenna says that knowledge derived from experience is conditional, which is to say that the character of this thing that is repeatedly perceived is necessarily joined to something that holds always in the domain in which the thing is repeatedly perceived, unless there is an obstacle. This point is applied to the example of the Sudanese as follows:

When procreation is taken to be procreation by black people, or people of one such country, then experience will be valid. If procreation is taken to be that of any given people, then experience will not end with the aforementioned particular instances; for that experience concerned a black people, but people absolutely speaking are not limited to black people.[248]

[247]Richardson, Kara,(2015)
[248]McGinnis, Jon and David Reisman, (2007), *Classical Arabic Philosophy: An Anthology of Sources*, Indianapolis: Hackett.

So, in response to the objection that experience could lead to false generalizations, Avicenna advises that proper use of experience would include careful attention to the domain of a species, which was subject to repeated observation[249].

3. Alhazen's Method of Empiricism and its Contributions to Advancing Science

The Aristotelian teachings permeated into Islamic culture, influencing also the theological debates within the religious caliphate. Like many other scholars of his time, Ibn al-Haytham (d.1040) began his search for truth by finding "*solace in the thoughts of Aristotle*"[250]. Over the years Ibn al-haytham becomes a well-versed man of science as he "*expounded the theories…of Aristotle, Galen and Ptolemy and was devoted on philosophy, physics, medicine, optics, astronomy, and mathematics*"[251]. Alhazen's life works were extensive, as many as two hundred works, many of which will eventually be lost, yet his seven volumes on optics will survive and be widely considered his most important intellectual contribution to a particular field of study. Ibn al-Haytham was entranced by the very complexity of light and visual perception. His seven volumes on optics as a complete work was entitled *Kitab al-Manazir*, translated into The Book of Optics. It is because of the extensive work Ibn al-Haytham performed that he is considered to this day by many as "*one of the most significant figures in the history of optics between antiquity and the 17th century*"[252]. His *Kitab* goes on to alter the thinking of many European scholars centuries after he has pioneered that field of study. Alhazen's scientific advances contributed a vast supply

[249] Richardson, Kara,(2015)
[250] Morgan, Hamilton, M .(2007), *Lost History The Enduring Legacy of Muslim Scientists, Thinkers, and Artists*, Washington,National Geographic Society.
[251] Gorini, R. (2003) "Al-Haytham the Man of Experience First Steps in the Science of Vision." *Journal of the International Society for the History of Islamic Medicine (JISHIM). Vol. 2. No. 4 (2003): pg. 53-55. Web. 21 Jan. 2012. <http://www.ishim.net/ishimj/not used/not used/JISHIM VOL.2 NO.4 PDF.*
[252] Gorini, R. (2003)

of knowledge "*in the history of both medicine and optics and [had] modified the idea that ancients had about light*"[253]. Along with other significant findings, Ibn al-Haytham disproved the ancient Greek notion of the visual perception of the human eye. Light was Alhazen's primary interest and he sought to discover the truth whether it was contrary to the Greek theories like those of Ptolemy and Aristotle[254].

The concept of visual perception, accepted by the Greeks, was known as the extramission theory. Many Greek scholars, including Ptolemy, disputed this particular theory. It was, supposed that the eye sends out rays of light to view the objects. Aristotle advanced his theory called the "*Mediumistic Theory by which the eye receives rays rather than direct them outward. In particular…in the process of human vision the object being looked at somehow altered the medium between the object itself and the viewer's eye*"[255]. Both theories proved to provide insufficient evidence and support and thus according to Alhazen's belief the theories had to be rejected.

The Greek scholars made connections between the light and eye sensations but failed to actually explain how it connected to vision perception. Ibn al-Haytham based his studies on Aristotle's initial theory, yet instead of basing theory on speculation, he wished to validate his theory upon scientific outcome[256]. In his Kitab Ibn al-Haytham gives his observations about the nature of light on the human eye:

"*We find that when the eye looks into exceedingly bright light, it suffers greatly because of them and is injured; for when an observer looks at the body of the sun, he cannot behold it well, since his eye experiences pain because of its light. Similarly, when he looks into a polished mirror, above which rises the light of the sun, and his*

[253] Gorini, R. (2003)
[254] Rathburn, E.A.(+2016), Alhazen's Method of Empiricism and its Contributions to Advancing Science, http://humanstudy.org/2016/12/25/alhazens-method-of-empiricism-and-its-contributions-to-advancing-science/,Summer 2020.

[255] Gorini, R. (2003)
[256] Rathburn, E.A.(2016)

eye is in the place to which the light is reflected by the mirror, he will again experience pain because of the reflected light reaching his eye from the mirror, and he will not be able to open his eye to observe that light"[257]

This writing supports Alhazen's findings, leading to the intromission theory, that the eyes receive rays of light rather than emanating rays in order to visually perceive objects. Through extensive and carefully planned investigation, "*Alhazen's most effective refutation of the extramission theory was his own positive intromission theory*"[258]. Ibn al-Haytham provided an answer to the question of vision that was founded in the physical proof of natural science. Unlike his predecessors he realized more truth was yet to be discovered and, held that visual perception is not a mere sensation but is primarily an inferential act of discernment and judgment. Ibn al-Haytham recognized that in order to understand optics, one must make greater connections between light, mathematics, and the anatomical properties of the human eye. The refutation of the extramission theory was one of Alhazen's multiple contributions to the understanding of optics. Alhazen's unique methods led to what Lindberg believed to be one of the principle merits of Alhazen's theory of vision in which he, successfully integrated the anatomical, physical, and mathematical approaches to sight. No other man before Ibn al-Haytham utilized many areas of study to define so thoroughly the concept of optics. His extensive scientific work proved to be important because it challenged the works of his Greek predecessors[259].

In all of his studies Ibn al-Haytham restricted his knowledge to the physical limitations of the natural sciences. Ibn al-Haytham recognized that in the works of Greek, Physical knowledge is found to be mixed up with metaphysical speculations. So instead of accepting the knowledge of his Greek predecessors, he sought to

[257]Lindberg, David C. (1976) *Theories of Vision from Al-Kindi to Kepler*. London, University of Chicago Press.
[258]Ibid
[259]Rathburn, E.A.(2016)

advance it. And he did this by substituting free investigation for authoritarianism[260]. This relates back to Alhazen's initial hunger to seek truth despite what knowledge society deemed to be absolute. Ibn al-Haytham will one day be recognized as the man to, "*shrine empirical method over faith and unsubstantial theory*"[261]. To look at one of his works it would be apparent that Ibn al-Haytham developed a revolutionary way of investigating theoretical hypotheses of natural science. These developments paved the way for a new dynamic way of scholarly learning.

Ibn al-Haytham brought Middle-Eastern scholarship out of the educational system of scholastic research clouded with metaphysical speculation, and into a sphere of dynamic experimental science. In order to pursue his own studies Ibn al-Haytham developed a precise and controlled system of empiricism in which his conclusions were founded upon investigation and experience. Facts were not valid unless verified through personal experience and so "*the core lessons of his writings is that science must be based upon empirical methods*"[262]. According to Ibn al-Haytham, this was the only way scientific knowledge could be validated. The Greeks did have an understanding of empiricism, but were prone to intellectual theorizing rather than gaining knowledge through research. It is important to understand that Ibn al-Haytham, "*did not rely upon authority in scientific conclusions but believed in direct study of Nature*"[263]. Alhazen's method of learning could be viewed as only an attempt to end the quarrels he had once been immersed in as chief minister during theological disputes. These quarrels were only the result of the lack of progressive thinking necessary for a methodical system of dynamic learning. It was Ibn al-Haytham who advanced this new concept in Muslim culture[264].

[260]Saud, M. (1990)
[261]Morgan, Hamilton, (2007)
[262]Ibid
[263]Saud, M. (1990)
[264]Rathburn, E.A.(2016)

Ibn al-Haytham acknowledged the lack of method and definition in the way his culture sought knowledge and ultimately succeeded in a remedy. Ibn al-Haytham "*was the pioneer of the modern scientific method…established experiments as the norm of proof in the field*"[265]. Today's scientific method is directly reflective of Alhazen's methods as written in his *Kitab* in which he outlines his empirical method:

"*We shall commence our investigations of the existing objects through induction and by searching for conditions of the visible objects and by distinguishing between the characteristics of individual objects. And out of the characteristics associated with sight we shall inductively select those which are permanent and immutable and those which are quite clear and not ambiguous during the process of seeing. Then we shall advance in investigation and syllogism gradually and in order, criticize the premises and secure conclusions against errors.*[266]". This passage can be divided into a series of steps Ibn al-Haytham took to investigate a particular study. First was the formulation of a Hypothesis and its Verification, second the Observation of Particulars, third the Classification and Selection of relevant data, and lastly Gradual Induction[267]. Alhazen's method was so exact that if certain observations were not in cohesion with a hypothesis, that particular hypothesis was rejected. Alhazen's method "*consisted of a repeating cycle of observations, hypothesis, experimentation and the need for personal verification*"[268]. Ibn al-Haytham can be attributed with some of the initial use of scientific words that are commonly used today as he, "*accurately employs the terms experiment, experimentation, examiner, observer, and find in his study of optics and visual*

[265] Gorini, R. (2003)
[266] Saud, M. (1990)
[267] Ibid
[268] Gorini, R. (2003)

perceptions"[269]. These terms could only be found in the writings of a dynamic scholar, for it is already justified that the Greeks had no ambition to pursue scholarly research. In his *Kitab,* he writes:

"Let an experimenter take a solid body, make a tiny hole in it, then hold it opposite the sun. He will find that light goes through the hole, moving along a straight line. If he tests the light as it extends through space, he will find it to be perfectly straight. It is therefore clear from all this that the light of the sun only extends along straight lines."[270]

The basic idea of light travelling in straight lines, so common to us now, was not accepted and had not been proven until Ibn al-Haytham sought to prove it through his unique empirical method. Ibn al-Haytham was a prolific writer, whose empirical and rationalized research went to cover multiple facets of the study of optics, and whose influence spread past the borders of the Muslim world, into the beginning of the European Scientific Revolution[271].

Through the scientific revolution, it was Alhazen's new method of epistemology based upon empirical method that "*gave sense-perception its proper role in the process of cognition, a role which has…been totally…subordinate to intuition on the Aristotelean theory of knowledge. This theory gave Greek its 'axiomatic' approach, so valuable for mathematics, but so stultifying for natural science*"[272]. From the beginning it was Ibn al-Haytham who turned away from the idea of self-evident scientific law and turned knowledge rather into validated and probable theories in the realm of natural science[273].

[269]Khaleefa, O. (1999), "Who is the Founder of Psychophysics on Experimental Psychology?" *American Journal of Islamic Social Sciences*. 16.2.
[270]Morgan, Hamilton, (2007)
[271]Rathburn, E.A. (2016)
[272]Omar, S. (1979), "Ibn al-Haytham's Theory of Knowledge and its Significance for Later Science." *Arab Studies Quarterly*. 1.1
[273]Rathburn, E.A.(2016)

4.Ibn Rushd's methodology:

Ibn Rushd (d. 1198 in Marrakesh) was the personal physician to the caliph and his son Abu Yusuf in 1184. He was a polymath who wrote about many subjects, including physics, psychology, astronomy, philosophy, law and jurisprudence. He influenced Maimonides, Thomas of Aquinas, Albert Magnus, Boethius of Dacia, Siger of Brabant, Barukh Spinoza and many more European philosophers. His medical work *Kitab al-Kulliyat fi al-Tibb* "collegiate" is was a veritable encyclopedia of medicine in ten volumes containing revolutionary discoveries such as pulmonary blood circulation and physiology. The text is oriented by the idea considering that in the field of medicine general truths lie beyond those gathered by observation, in the linking up of phenomena with their causes. As it is stated in Book I, the medicine reposes on demonstrations founded in natural philosophy, challenging the kind of medicine which is centered entirely on results. But when it comes to the treatment, the author founds his remedies on an inductive approach based on observing the effects of medicines[274].

Through observation he defined a new methodology of research to detect symptoms, thus opening the door to scientific reasoning. He interpreted and commented on Aristotle's and Plato's works, which were subsequently translated into Latin and Hebrew and had great influence on Europeans philosophers.

[274] Abattouy, M. (2012), *Averroes*, https://muslimheritage.com/ibn-rushd-averroes/ visited in autumn 2020

VIII- Influence of Muslim Thought on the West

Muslim philosophy influenced Western thought in several ways. The Muslims were the first humanists and they gave a humanist bend to the Western mind. They were the first to reveal to the West that outside the prevailing Catholic Church it was not all darkness and barbarism but an untold wealth of knowledge. They captured, interpreted and further developed all the intellectual achievements of Greece and transmitted them to the West even before any direct contact between the Greek intellect and the Western mind was established.

It was through their influence that ancient and contemporary men outside the Christian West also began to be looked upon as human and even belonging to higher civilizations.[275]

Nothing can prove their own humanism better than the fact that within eight years of the establishment of Baghdad they were in possession of the greater parts of the works of Aristotle (including the spurious Mineralogy, Mechanics, and Theology), some of the works of Plato and the Neo-Platonists, the important works of Hippocrates, Galen, Euclid, Ptolemy, and subsequent writers and commentators, and several Persian and Indian writings on mathematics, astronomy, and ethics.

All this was taking place in the Muslim world when Greek thought was almost unknown in the West. While in the East "*al-Rashid and al-Mamun were delving into Greek and Persian philosophy, their contemporaries in the West, Charlemagne and his lords, were reportedly dabbling in the art of writing their names*."[276]

[275]Sharif, M.M.(1959) "Muslim Philosophy and Western Thought,", Lahore, Iqbal, Vol. VIII, No.1

[276]Barthold, Mussulmane Culture, quoted in Sharif, (1963)

1. The reception of Muslim philosophy in the Christian West

Humanism spread to Western Europe through contact between the Muslims and the non-Muslims in Spain; to Italy by a similar contact in Sicily; and throughout Europe by the impress of a higher culture received by the Crusaders in Syria and Asia Minor. Since Islam originated from monotheism, it conceived idolatry as its real enemy and acted with the purpose of subduing it first in the Arab lands and then throughout the world. The Qur'an accepts Christianity and the Jewish religion as divine religions; therefore, it did not instigate any struggle against them. However, Christianity first conceived of Islam as a competitor and, therefore, attacked it directly[277].

The Arian and Nestorian sects of Christianity had a positive outlook on Islam since they were monotheistic in outlook. As compared to Islam the doctrine of the Trinity and the Monophysite mode of thinking retained the residues of idolatry. The places of ancient Jupiter, Apollo, Venus were given to God, Jesus, and Mary. Since the iconoclasticism of Islam was against their frame of mind, the Christians started a religious struggle against Islam.

The following verses from the Qur'an indicate that in Islam there is no obligatory doctrine but religious tolerance: *Lakum din-u-kum wa li-ya din* (you have your religion and I have mine); *la ikra'ha fi al-din* (religion is not to be forced on anyone). On the other hand, the idea of proselytism is dominant in Christianity. Christianity indoctrinates that it is the only way to spread and spreading is its main duty[278].

In spite of this principle in Christianity, the spread of Islam in all domains from the first *Hijrah* on not by wars but sporadically was much more rapid. The main reason for this is in the capacity of the Arabic language and in the Islamic custom of not collecting taxes and duties from defeated nations if they accepted Islam. Although

277 Sharif, (1963)
278 Ibid

these sociological factors play a significant role, the ease in accepting a natural and rational religion and its consistency with human idealism is additional reasons for the spread of Islam[279].

The Christian reaction to Islam in the East and West took different forms. Those who criticized the new religion vehemently and did not wish to accept it as a religion at all come first. John of Damascus in his book De Haeresibus, considered Islam to be heresy. The first Byzantine writer who referred to the Prophet was Theophanes the Confessor (202/817). He also attacked Islam as severely as John. Guilbert de Nogent's (518/1124) criticism was based on the fact that wine and pork were tabooed in Islam[280].

As an exception, Hilderbert de Lemans for the first time, in the Middle Ages in the West, stated that Muhammad was a real Prophet and he did produce miracles. Guillaume de Tripolis' work on Islam was written with extreme hate and was most offensive. Its descriptions were far from reality, being a mixture of mythical elements with history.[281]

Peter de Cluny (d. 551/1156) translated the Qur'an into Latin for the first time. His work set the foundation for St. Thomas' attacks on Islam. St. Thomas referred to Islam and to its theologians. He is the first to give his criticisms a philosophical orientation. Raymond Lull (633-716/ 1235-1316) studied Arabic at Majorca and Muslim philosophy in Bugia near Tunisia. It was he who suggested to the then Pope to start the moral crusade against Islam. This suggestion which was met at first with complete disinterestedness was later accepted by the Popes after Raymond's long endeavor to that effect; it became indeed the foundation of the Missionary movement[282].

[279]Sharif, (1963)
[280]Ibid
[281]Von Grunebaum, G.E. (1946) *Medieval Islam*, Chicago.
[282]Sharif, (1963)

It was at first rather difficult for the Western philosophers to get rid of religious, imperialistic, and racial prejudices and look at Islam and the East with understanding. In spite of the fact that the Renaissance became possible only through plagiarizing and profiting by Muslim works on philosophy, and science, subject to the censorship of clerics, the layman was denied access to this knowledge for centuries: Christus vincit, Christus regnat, Christus imperat (victory, reign and empire). Hence, the attitude of some Western people who were hostile to the very civilization that created these works explains how deep-rooted the religious, political, and racial prejudices had become[283].

From the eleventh/seventeenth century on, {after Reformations and revolutions against these clerics}. Western philosophers gradually got rid of their prejudices against Islam. Cultural and intellectual influences from the Muslim East for centuries were instrumental in bringing about that change. From the twelfth/eighteenth century on, the attitude of Western free thinkers took a truly humanistic turn. The libre penseurs took a stand against negative and malicious publications. Edward Sale, in the preface he wrote for his translation of the Qur'an in 1147/1734, likens the Prophet to Thesee and Pompillus. He praises his philosophy, his political views, and his realism. Boulainvilliers in his book, The Life of the Prophet, going one step further tried to prove that Islam is superior to Christianity in rationalism, realism, and its consistency with the nature of man[284].

[283]Sharif, (1963)
[284]Ibid

2. The transmission of Muslim thought to the medieval West

Interest in Muslim philosophy developed in Europe towards the end of the fifth/eleventh century. The Muslim rule in Spain, the Crusades, the seminaries in Sicily, the inadequacy of the old Western scholastic and scientific systems, the density of population and internal congestion necessitated relations of the West with the world of Islam. In Toledo Muslims and Christians lived side by side. It was there that Raymond I, Archbishop of the provincial capital (525/1130-545/1150), established a translation bureau to render Arabic masterpieces into Latin[285].

In France and especially in Normandy, having seen William the conqueror's success with Muslim designs and scientific trends in England, the Frankish rulers thought about imitating their cousins. {appeared first among the monks} Robert, the King of Isle de France of the Capetian dynasty, was friendly towards the Muslim scientific endeavor. At the time he invaded Southern Italy, Calabria, and Sicily, he observed the Italian seminaries and borrowed many things from them. In that way, the seminaries of Sicily and Naples acted as transmission media of Islamic science to the West. On the other hand the clerics, who saw the threat to their archaic teaching, started to reform their discipline under the hawk eye of Bernard de Clairvaux (d.1152). The latter created Citeaux and 500 sister abbeys that spread all over Europe. Monks from many European areas were sent to collect, translate and copy works from Arabic.[286]

The Arabic-Latin translation movements in the Middle Ages, which paralleled that from Greek into Latin, led to the transformation of almost all philosophical disciplines in the medieval Latin world. The impact of Arabic philosophers such as al-Farabi, Ibn Sina and Ibn Rushd on Western philosophy was particularly strong in

[285] Sharif, (1963)
[286] Ibid

natural philosophy, psychology and metaphysics, but also extended to logic and ethics[287].

Arabic Philosophy was known in the Latin West through translations, and, to a small degree, through personal contacts between Christians and Muslims, as in the case of Frederick II Hohenstaufen, who was directly acquainted with a number of Muslim scholars. A small number of Christian scholars, such as Ramón Martí and Ramón Llull, knew Arabic themselves and drew on Arabic sources when composing Latin works. Translations, however, were far more influential. The first Arabic-Latin translations to transport philosophical material into Latin Europe were the translations of texts on medicine and natural philosophy produced towards the end of the eleventh century in Italy, most of them by the translator Constantine the African, who, in contrast to later translators, tried to disguise the Arabic origin of his texts[288].

The translations of philosophical texts proper, such as by al-Kindi, by the anonymous author of the *Liber de causis*, by al-Farabi, Isaac Israeli, al-Ghazali and Ibn Sina, but also of Greek works transmitted in Arabic, assumed full pace in Toledo in the second half of the twelfth century, where two very prolific translators worked: Gerard of Cremona and Dominicus Gundisalvi. It is likely that al-Farabi's treatise *Enumeration of the Sciences*, translated twice, by Gerard and Gundisalvi, served as a model for a coherent translation program. The impressive Spanish translation movement was motivated and fostered by several factors: the personal interest of individual translators; the demand for scientific texts by the French schools; the availability of Arabic manuscripts in cities newly conquered by the Christians; the

[287]Hasse, Dag Nikolaus, (2020) "Influence of Arabic and Islamic Philosophy on the Latin West", *The Stanford Encyclopedia of Philosophy*, Edward N. Zalta (ed.), URL =https://plato.stanford.edu/archives/spr2020/entries/arabic-islamic-influence/ accessed in June 2020.

[288]Burnett, (2006), "Humanism and Orientalism in the Translations from Arabic into Latin in the Middle Ages", in A. Speer and L. Wegener (eds.), *Wissen über Grenzen. Arabisches und lateinisches Mittelalter*, Berlin: deGruyter, 22–31.

patronage of the archbishop of Toledo; and by clerical interests in promoting Latin scientific culture in an Arabic-speaking Christian environment[289].

The next important phase of the transmission were the translations made in Sicily and southern Italy by several translators associated with the Hohenstaufen or the papal court, the most productive of which were the Averroes translators Michael Scot and William of Luna. It was only about thirty years after Averroes' death in 1198 that Latin Averroes translations became available in the newly developing universities. In 1255, the statutes of the Parisian arts faculty declared all known works of Aristotle mandatory reading for the students – a very influential move, which much contributed to the rise of Averroes' commentaries as the principal secondary literature of Latin university culture[290].

After about 1300, Arabic-Latin translation activities ceased almost entirely, to resume again after 1480. The Renaissance translations were mostly produced by Italian Jews from Hebrew versions of Arabic texts, an exception being Andrea Alpago's Avicenna translations from Arabic, which were produced in Damascus. The social context of these translations was the vibrant philosophical culture of Italian universities and especially of Padua, and the patronage of Italian scholars belonging to the Italian nobility, who had been educated in these universities. The impact of these Renaissance translations, which is weaker than that of the medieval translations, remains largely unexplored[291].

The transmission of Muslim thought to the medieval West passed through the following phases:

[289] Hasse, (2006), "The Social Conditions of the Arabic-(Hebrew-)Latin Translation Movements in Medieval Spain and in the Renaissance", in A. Speer and L. Wegener (eds.), *Wissen über Grenzen: Arabisches Wissen und lateinisches Mittelalter*, Berlin: de Gruyter, 68–86 and 806.
[290] Hasse, Dag Nikolaus, (2020)
[291] Ibid

1. In the first phase, a band of scholars went to Muslim countries and made personal studies. Constantine of Africa and Adelhard made studies of this sort for the first time. Constantine, who was born in Carthage near the end of the fifth/eleventh century, travelled all through the East. He made translations into Latin from the Arabic translations of Hippocrates' and Galen's books in addition to those of the original works of Muslim scholars on medical science. Later on, many students from Italy, Spain, and southern France attended Muslim seminaries in order to study mathematics, philosophy, medicine, cosmography, and other subjects, and in due course became candidates for professorship in the first Western universities to be established after the pattern of the Muslim seminaries[292].
2. The second phase starts with the founding of the first Western universities. The style of architecture of these universities, their curricula, and their method of instruction were exactly like those in the seminaries. First, the Salerno seminary was founded in the kingdom of Naples. Courses were offered in grammar, rhetoric, logic, arithmetic, music, geometry, and cosmography. Books of Aristotle and those on the interpretation of his philosophy were brought to Italy by way of Salerno. Emperor Frederick of Sicily was known as a patron of Muslim science. He founded the seminary at Naples. Aristotle's books were translated from Arabic into Latin by his order. Alphonso X, King of Castile and Leon (650/1252-683/1284), ordered that astronomical tables be made following a study of Arabic works. At that time, important seminaries were also established at Padua, Toulouse, and later at Leon. At last, the science of the Muslims was transmitted to France and to other Western countries via Toledo and Italy.

[292] Sharif, (1963)

Bologna and Montpellier seminaries were founded at the beginning of the seventh/thirteenth century. The University of Paris opened its doors for instruction somewhat later[293].

3. At that time Oxford and Koln Universities were established after the same pattern and thus the new science was transmitted to England and Germany[294].

Scientific study was made possible mainly by the influx of Arabic books from the Islamic world through Spain, and by the introduction of a new method based on the new logic (*logica nova*) of Aristotle, introduced into the Latin West in the second half of the twelfth century. The new studies appeared, in succession: medicine, first, in Salerno, followed by law in Bologna, then theology in Paris[295].

3. Introducing Empiricism

Natural philosophy is the field with the greatest number of Arabic-Latin translations. In this discipline, Arabic philosophers had been particularly active, and Latin philosophers were particularly interested. Arabic natural philosophy reached the Latin West earlier than the other philosophical disciplines. The medical and astrological translations of the late eleventh and early twelfth century transported much philosophical material of the Graeco-Arabic tradition to the Latin world[296].

The greatest boon that the Muslim East bestowed upon the West was the scientific or inductive method of inquiry. Although most of the Muslim thinkers used the inductive method in their scientific investigation in different fields, the two of them who particularly expounded this method were Muhammad bin Zakariya al-Razi and ibn al-Haytham. It was the method of observation and experiment which led al-

[293] Sharif, (1963)
[294] Ibid
[295] George Makdisi, (1981), *The Rise of Colleges: Institutions of Learning in Islam and the West* ,Edinburgh University Press, Edinbrugh.
[296] Hasse, Dag Nikolaus, (2020)

Biruni to the discovery of reaction time, al-Kindi to the formula that sensation is a response of the organism proportionate to the stimulus, and ibn al-Haytham to his findings in optics[297].

The influence of the Muslim method of observation and experiment on the West has been recognized by Briffault in the following terms. "*Numerous Jews followed William of Normandy to England and enjoyed his protection ... establishing a school of science at Oxford; it was under their successors at that Oxford school that Roger Bacon learned Arabic and Arabic science*."[298]

During the seventh/thirteenth century, the Oxford school became a centre of the activities of translation and interpretation. Here for the first time Alexander Neckam translated from Arabic Aristotle's books "*On Heaven*" and "*On Soul*." In the same School Michael Scot translated into Latin a book by al-Bitraji (Albatragius) on cosmography and several books by ibn Sina and ibn Rushd. Robert Grosseteste was another member of the Oxford Group (651/1253). His efforts were noted in the translations of Greek and Muslim philosophical works. Roger Bacon (c. 1214-1294), was the most important member of this group. This great scholar who made researches in language, mathematics, and biology became known as a magician and occultist during the Middle Ages and was, therefore, convicted; in fact he was one of the founders of empiricism. The influence of Muslim philosophers on Roger Bacon particularly that of ibn Sina, was very great[299].

The word "experiment" (experimentum) is closely associated with his scientific and extra-scientific studies. While the trends initiated by ibn Sina and ibn Rushd

[297] Iqbal, M. (1954), *The Reconstruction of Religious Thought in Islam*, Lahore
[298] Briffault, (1928),*The Making of Humanity*, London, pp. 200-01
[299] Sharif, (1963)

constituted the roots of Western rationalism, Muslim naturalists like al-Razi and ibn Haitham influenced the empirical thought of England[300].

The best known Polish author during the translation period was Wittelo (b. 628/1230). Wittelo went from Poland to Italy. He compiled an important work about Greek and Muslim scholars. In his book entitled Perspective, there were important selections from Euclid, Appolonius, Ptolemy's Optica, and ibn Haitham's *Kitab al Manazir*. Wittelo and Roger Bacon carried further ibn Haitham's work in physical research[301].

Preserved in his writings Alhazen's empirical method influenced the works of European methodologists such as Galileo, Roger Bacon (c. 1214-1294), and Johannes Kepler (c. 1571-1630) as well as many others. All of these men studied the works of Alhazen and it is believed by Selah Omar that, "*all other Latin works before then (17th c.) repeated Alhazen's experiments, expatiated his theories, or simply misunderstood much of his work*"[302]. However, while these men were not the innovators of such a useful scientific method, many European scientists used Alhazen's influence to better scholarly research and education. It was Alhazen's mathematical and optic theories that would, "*lay the foundation…for Galileo and Copernicus to understand the true relationship of the earth to other heavenly bodies*"[303]. Roger Bacon who was commonly believed by the English to establish empirical methods, produced his own writings which are largely commentaries on Alhazen's writings, and like Alhazen recognized that problems were still beyond the reach of human capabilities of the time. It wasn't until Johannes Kepler, a German Mathematician and Astronomer who was perhaps the

[300] Sharif, (1963)
[301]Ibid
[302]Omar, S. (1979), "Ibn al-Haytham's Theory of Knowledge and its Significance for Later Science." *Arab Studies Quarterly*.1.1
[303]Morgan, Hamilton, (2007)

first European to master Alhazen's experimental approach to science as well as further the great Muslim's studies[304].

"*Neither Roger Bacon nor his later namesake has any title to be credited with having introduced the experimental method. Roger Bacon was no more than one of the apostles of Muslim science and method to Christian Europe; and he never wearied of declaring that knowledge of Arabic and Arabic science was for his contemporaries the only way to true knowledge. Discussions as to who was the originator of the experimental method...are part of the colossal misrepresentation of the origins of European civilization. The experimental method of the Arabs was by Bacon's time widespread and eagerly cultivated throughout Europe; it had been proclaimed by Adelhard of Bath, by Alexander of Neckam, by Vincent of Beauvais, by Arnold of Villeneuve, by Bernard Silvestris, who entitles his manual Experimentarius, by Thomas of Cantimpre, by Albertus Magnus*."[305]

"*The debt of our science to that of the Arabs does not consist in startling discoveries of revolutionary theories; science owes a great deal more to Arab culture, it owes its very existence. The ancient world was, as we saw, pre-scientific. The astronomy and mathematics of the Greeks were a foreign importation never thoroughly acclimatized in Greek culture. The Greeks systematized, generalized, and theorized, but the patient ways of investigation, the accumulation of positive knowledge, the minute methods of science, detailed and prolonged observation and experimental inquiry were altogether alien to the Greek temperament. Only in Hellenistic Alexandria was any approach to scientific work conducted in the ancient classical world. What we call science arose in Europe as a result of a new spirit of*

[304] Rathburn, E.A.(2016)
[305] Briffault, (1928)

inquiry, of new methods of investigation, of the methods of experiment, observation, and measurement, of the development of mathematics in a form unknown to the Greeks. That spirit and those methods were introduced into the European world by the Arabs"[306].

While many Latin writers of the twelfth century continued to understand nature in terms of the Latin Christian tradition, others, in the context of the so-called "school of Chartres", such as William of Conches, Adelard of Bath, Hermann of Corinthia and Bernardus Silvestris, drew amply on the new medical and astronomical sources, often combining them with the doctrines of Plato's *Timaeus*. Sometimes they did this by openly dividing their presentation into a section according to the church fathers and a section according to the philosophers and natural scientists (*physici*), which integrated material from the Latin and Arabic philosophical traditions (e.g. the treatises *Philosophia* by William of Conches and *De natura corporis et animae* by William of St.-Thierry).[307]

In the University of Paris, from the day it was established in 612/1215, much importance was given to Aristotle's texts and their interpretations in Arabic. From 629/1231 on, the Pope Gregory IX renewed the decree against the instruction of Aristotle and his texts. In the following years the Pope's actions against the universities became increasingly severe. Bacon, Duns Scotus, and Nicholas of Autrecourt were convicted. Investigations were made about the Averroists; they were convicted and circulation of their books was prohibited. These severe actions continued until the end of the eighth/fourteenth century[308].

These severe measures which had originated from fanaticism had ideological roots too. In general, they embodied a reaction against Aristotelianism. The tendency

[306] Briffault, (1928)
[307] Rathburn, E.A.(2016)
[308] Sharif, (1963)

of Platonism and dialecticism against Aristotelianism and "experimentationism" was again aroused. Muslim philosophy was unable to meet the needs of the West when it came to Plato's Dialogues. For, many of them were not known to the Muslims. Those that were known were incomplete.Philosophy and science were regarded as antagonistic to religion. Hence the teachings of Aristotelianism and Averroism were banned, Bruno was burnt, Kepler was persecuted, and Galileo was forced to retract[309].

At the end of the ninth/fifteenth century extensive publication of books translated into Latin from Arabic rendered the decrees by the priests partially ineffective and these books rapidly spread everywhere, even outside the university curricula; while the mental orientation towards experimentation was now struggling against reaction in the fields of ideology and research, the ground was being laid for the Renaissance. The translation into Latin of the works of abu Bakr Zakariya al-Razi, founder of the philosophy of nature in Islam, was an important step in the transmission of Muslim philosophy to the West. Constantine the African translated into Latin two philosophical works of al-Razi, *Kitab al-'Ilal and Sirr al-Asrar*, and Gerard of Cremona translated *al-Mansuri*. Al-Razi's greatest work *Kitab al-Hawi* (Liber de Continens) was translated into Latin and the Latin translation was published several times. It was translated by Faraj ben Salim known as Faragut, a Jew educated at Salerno, in twenty-five volumes, under the orders of the King of Naples. It was first published in 892/1486 in Brescia, then in Venice in 906/1500, 912/1506, 915/1509, and 949/ 1542. Al-Razi's influence was not confined to the Latin translation of his works only; it led further to the translations of other Muslim philosophers who referred to him in their works[310].

[309]Sharif, (1963)
[310]Ibid

The famous Jabir bin Hayyan is known among the naturalists as an alchemist, chemist and philosopher. He is known in the Latin world better than in Islam, not as a philosopher and chemist but as a magician and alchemist. *Summa perfectionis magisteri* is a translation of his collected works[311].

Many of al-Kindi's books were translated into Latin. Plato of Tivoli translated his book on the problems of geometry; Arnold of Villanova, his books on degrees under the title *De Gradibus*; Robert the Englishman, his book on astronomy entitled "On the Dragon"; and *De Azogont*, his book on physics and meteorology. This last book was first printed in Venice in 913/1507 and then in Paris in 947/1540.One of al-Kindi's important books, *Kitab al-'Aql* (Book of the Intellect), was translated into Latin perhaps by John of Seville under the title *De Intellectu*. Gerard of Cremona also translated some books by this philosopher. In the West, al-Kindi was known as one of Aristotle's faithful disciples and, therefore, for a long time, was considered to be a heretic. However, with his works and those of his successors, empiricism penetrated into the West from the Arab world and helped the rise of modern thought[312].

The philosophical development of the great Arab physicist ibn Haitham (Alhazen) proceeded from skepticism to a kind of criticism. The evolution from skepticism to his own ideological synthesis, he owed to al-Farabi. The Latin translations of some of ibn Haitham's books written during his empiricist and skeptical periods were instrumental to the development of Roger Bacon's ideas. In addition to this, Western science profited by ibn Haitham's detailed research on optics. He really marks the beginning of physics as well as that of the movement of empiricism in the West. In the origination of empiricism, his role is even greater than that of al-Razi. Ibn Haitham explained the role of induction in syllogism. He criticized Aristotle for the

[311]Sharif, (1963)
[312]Ibid

meagerness of his contribution to the method of induction which he regarded as superior to syllogism. He considered it to be the basic requirement for true scientific research.[313]

Besides his analysis of light, ibn Haitham devoted the major part of his book to a detailed discussion of the problem of perception. He studied the perception of darkness, distance, position, body, size, and then in the mental field, the perception of proportion, appearances, and beauty. He saw the relation between perception and reflection and showed great acuteness in explaining how true knowledge is founded on these two processes. He held that knowledge combines the substance of the intellect with the content of experience and, thus, reconciled rationalism with empiricism[314].

The introduction of Arabic philosophy into Latin Europe led to the transformation of almost all philosophical disciplines. The influence is particularly dominant in natural philosophy, psychology and metaphysics, but is also felt in logic and ethics. The Arabic impact is particularly strong in the thirteenth century, but some Arabic traditions, such as Averroes' intellect theory, reached the high point of their influence in Latin Europe as late as around 1500.[315]

Muslim thinkers, following Plato, Aristotle, and Plotinus, harmonized faith with reason and made possible, for themselves and for Europe, the unhampered development of both.

Medieval Islamic medicine introduced several aspects of medical research which anticipated modern clinical trial designs. The need for experiments in medical practice, the importance of animal studies before treating patients with a drug and acknowledgment of the differences between the physiologies of animals and humans,

[313]Sharif, (1963)
[314]Ibid
[315]Rathburn, E.A.(2016)

treatment comparisons to a control group, appreciation of uncertainty in medical practice, and introducing statistics to medical research can all be traced back to the rich medieval Islamic medical literature.

Nearly half a century ago Fonahn enumerated no less than one hundred and fifty-one works on Persian medicine alone during this period[316] and Max Meyerhof says that "*the treasure-houses of Islamic science are just beginning to be opened. In Constantinople alone there are more than eighty mosque libraries containing tens of thousands of manuscripts.In Cairo, Damascus, Mosul, Baghdad, as well as in Persia and India there are other collections.... Even the catalogue of the Escorial Library in Spain which contains a part of the wisdom of Western Islam is not yet complete.*"[317] The subject of Muslim medicine is so vast that in the precedent pages only a bird's-eye view of it can be given.

[316]Sharif, (1963)

[317]Max Meyerhof, (1942) "Science and Medicine," *The Legacy of Islam*, p. 311

PART II:

The Evolution of Clinical Trials in Western Civilization

I- Introduction

In the first part of this thesis, we have given evidence of expanded interest and exchange of scholarly effort and studies between the Greek and Latinate Europe and the wider Arabic speaking and Muslim areas of Europe, North Africa, the Levant and Central Asia. A large corpus of scientific, medical, philosophical and literary knowledge was passed from Muslim scholarship into the Latin based and Christian centers of learning, colleges, and monasteries and to individual scholars in Europe.

As a result of this intensive and impressive scholastic work, a revolution in the sciences, medicine and philosophy emerged in Europe.

In the second part, we will follow the major milestones that marked the evolution of clinical trials in the Western Civilization starting with the emerging of a wave of elite scholars with groundbreaking discoveries and inventions, leading the renaissance era physicians to challenge Galenic medical theory through experimentation. The second major breakthrough was the conceptualizing of clinical trials using numerical methods to assess medical intervention. Finally, we will go through the major attempts to refine clinical trials discipline to avoid different biases.

II- Challenging Galenic medical theory

In the early part of the medieval period, folk healers were all that existed to help anyone who was sick or injured. The term empiric was used as a pejorative by some during the Middle Ages when referring to folk healers; while the word generally is used to describe methodology based on experience, it was used by medieval physicians to describe those who practiced using skills honed through experience, but without regard to the science or “deep insight” into the problem. Empirics made up the largest group of health providers in medieval Europe, and both men and women were included.

Some of these empirics were generalists; others specialized in one type of care or another. Their approaches to treatment varied widely, from first-aid measures (simple cleaning and bandaging) to the use of medicinal herbs or prayers and magic.

Empirics had no formal training. Some likely studied under other healers but many learned medicine through experience, relying on their own instincts. Most of these healers understood and practiced the use of herbal folk remedies as well as bloodletting, cauterization, and cupping. The quality of overall care and the results varied greatly[318].

By the 12th century, European physicians understood that the Arabic practitioners were outdistancing them, and they began to seek out Arabic texts and translate them into Latin. This development was to have great influence on what was happening in the West.

As indicated in part I, one of the notable translators from Arabic into Latin was Constantinus Africanus (1020-87) who smuggled out a copy of Ibn Sina's works and established himself in Salerno where he was able to share his growing body of knowledge. Constantinus was able to make Ibn Sina's work accessible for the first time to western Europeans, and so westerners began to study its medical methodology. In addition to the translating that took place to spread information about Greek and Islamic practices, travelers also talked of the treatments they observed and noted the types of instruments used by Islamic practitioners.

Later Gerard of Toledo, Spain, (ca.1140) translated hundreds of works by Aristotle, Ibn Sina (Avicenna), Razi as well as Abu al-Qasim Al Zahrawi's (Albucasis) writings on surgery. The Qanun of Ibn Sina became the cornerstone textbook of

[318] Kelly, K. (2010), *The Middle Ages 500-1450*, Medieval Healers and Hospitals p.19

medicine at the University of Montpellier, the largest non-clerical institution in Europe until 1650[319].

By the 12th century, universities began to offer medical training to a very small group of clerics. Eventually some level of licensing came into play within the fields of medicine and surgery, and this provided some guarantee of a minimum level of training and education. Even during the latter part of the Middle Ages when physicians began to attend universities, there were actually very few schools, and those that existed tended to graduate only five or six individuals each year. Because there were so few people who emerged with these advanced degrees, few people would have had access to a university-trained physician. Those who had access to learning were the aristocracy but once they acquired knowledge their rank prevented them from exercising.

The creation of medical training programs in a university setting was one of the most important developments in medicine during the Middle Ages, and the men who trained at universities became the elite of the medical profession. The college movement began in the 12th century with the founding of colleges in Paris (1150), Bologna (1158), Oxford (1167), Montpellier (1181), and Padua (1222)[320].

[319]Kelly, K. (2010), p.23

[320]Ibid

1. Roger Bacon : the beginnings of experimental science in Europe.

Roger Bacon was one of the early scholars with a Master of Arts degree from the University of Paris in the 1240s. He was an innovative thinker and a courageous scholar, not afraid to challenge current beliefs about philosophy, science and religion.

Bacon was also one of the early Masters who taught Aristotle's works on natural philosophy and metaphysics. Sometime after 1248-49, he became an independent scholar with an interesting languages and experimental-scientific concerns. Between 1247 and 1267, Bacon visited Occitania (today's Southern France) mastered most of the Greek and Arabic texts on the science and mainly optics.

On the instruction of the Pope on June 22, 1266, Bacon quickly wrote "an introductory work," the *Opus maius*, and the related works, *Opus minus* and *Opus tertium*. He set out his own new model for a reform of the system of philosophical and theological studies, one that would incorporate language studies and science studies, then unavailable at the universities.

Roger Bacon is one of the earliest European advocates of the modern scientific method. He applied the empirical method of Ibn al-Haytham (Alhazen) to observations in texts attributed to Aristotle. Bacon discovered the importance of empirical testing when the results he obtained were different than those that would have been predicted by Aristotle.

He succeeded in setting out a model of an experimental science on the basis of his study of optics. The latter was used in his extension of experimental science to include new medicines and the general health care of the body. He did this in a new context: the application of linguistic and scientific knowledge for a better understanding of Theology and in the service of the *Res publica Christiana (the Christian Commonwealth)*. However, it appeared that Bacon was condemned to seventeen years in jail by his own Order in 1278, after the death of his previous supporter Pope Clement IV, "on account of certain suspected novelties." This may have been due to his interests in astronomy and alchemy[321].

Bacon holds that scientific knowledge is twofold: first, there is the "imperfect and confused knowledge" by which the mind is inclined to the love of the good and of truth. This implicit knowledge is innate. Second, there is explicit rational knowledge. One part of this has to do with the knowledge of the principles of science; the other is the knowledge of conclusions. This latter is complete knowledge though it is not exhaustive. Bacon's account of sense, memory, and experience reflects his own reading of Avicenna, the medical tradition, and works on optics. Bacon distinguishes *experientia* from *experimentum*. Experience (*experientia*) is the distinct knowledge of singular things, and all animals have this distinct knowledge of singulars. But not all animals have *experimentum*, that is, a science of principles based on experience. As he puts it, "*experience is the distinct reception of singulars under some aspect of universality, as is stated in the text [of Aristotle], but only the universal is grasped by the intellect. Therefore, only humans and not other animals have experience [experimentum]*"[322].

One can express Bacon's position as follows: *experimentum* is the universal source for our discovery of scientific principles. Scientific knowledge, once established, proceeds by demonstration. *Experientia* designates the simple perception of singulars. Only in a very loose sense can it be used of scientific knowledge.

Part VI of Bacon's *Opus maius – Experimental Science* – contains the passages for which he is principally remembered.

P 389 of the 15th Century Digby manuscript in the Bodleian Library in Oxford states:

[321]Hackett, Jeremiah,(2020) "Roger Bacon", *The Stanford Encyclopedia of Philosophy*, Edward N. Zalta (ed.), URL = <https://plato.stanford.edu/archives/sum2020/entries/roger-bacon/>.
[322]Ibid

Positis radicibus sapientiae Latinorum penes Linguas et Mathematicam et Perspectivam, nunc volo revolvere radices a parte Scientiae Experimentalis, **quia sine experiential nihil sufficientia sciri potest .**

Having laid down fundamental principles of the wisdom of the Latins so far as they are found in language, mathematics, and optics, I now wish to unfold the principles of experimental science, since **without experiment nothing can be sufficiently known.** *There are two ways of acquiring knowledge, one through reason, the other by experiment. Argument reaches a conclusion and compels us to admit it, but it neither makes us certain nor so annihilates doubt that the mind rests calm in the intuition of truth, unless it finds this certitude by way of experience. Thus many have arguments toward attainable facts, but because they have not experienced them, they overlook them and neither avoid a harmful nor follow a beneficial course. Even if a man that has never seen fire, proves by good re1asoning that fire burns, and devours and destroys things, nevertheless the mind of one hearing his arguments would never be convinced, nor would he avoid fire until he puts his hand or some combustible thing into it in order to prove by experiment what the argument taught. But after the fact of combustion is experienced, the mind is satisfied and lies calm in the certainty of truth. Hence argument is not enough, but experience is*[323]*.*

Bacon is making a point that brings to mind a passage in Ibn Sina's *Qanun*, written two centuries earlier, namely:

If it is said that some parts of medicine are theoretical and other parts are practical, this does not mean that one part teaches medicine and the other puts it into practice…both parts of medicine are science, but one part is the science dealing with

[323] Translated by Eva Oledzka and Bruce Barker-Benfield. Translations consulted: Bridges JH (1897). Oxford: Oxford University Press and Burke RB (1928). Philadelphia: University of Pennsylvania Press.

the principles of medicine, and the other with how to put those principles into practice.[324]

2. Stepping Away from Galen

The rise in university training in medicine and the documents from Islamic scholars being translated into Latin brought about a renewed interest in Greek medical thought whilst the documents from Islamic scholars were being translated into Latin to provide a scholarly background.

The atmosphere of change in so many aspects of society—from explorers back with reports of never-before-seen lands to economic and religious upheaval—created an environment that led to questioning the past. Even the church became subject to criticism as such people as Martin Luther began to point out the abuses of power that the church permitted its leaders.

The Black Death, which shrouded the Continent in 1347-48, was one of the deadliest pandemics in human history, brought about new thinking on the issue of autopsies, which had long been forbidden by the church and as a result held back medical progress because of the inability for physicians to study anatomy. As towns were wiped out by the Black Death and bodies were left to pile up in the streets because no one had the time to bury them, religious leaders wanted to know what was causing this terrible disease. As a result, they began to permit postmortem examinations of plague victims[325].

In the early 16th century, physicians still relied on the medical ideas of the Greek physician Galen, whose theories about medicine still guided all forms of analysis and treatment.

[324]Ibn Sina (c. 1012 CE; c. 402 AH*). Kitab al-Qanun fi al-tibb [Avicenna's The Canon of Medicine].*
[325] Kelly, K. (2010). *The Scientific Revolution and Medicine 1450-1700* p.2

2.1. Paracelsus

Paracelsus, who was born as Phillip von Hohenheim (1493-1541), was a brilliant but controversial figure in the world of medicine and introduced fascinating new theories that became very influential. Paracelsus was born in the Tirol mining district of what is now Austria, and he is thought to have gained a medical degree at the University of Ferrara where he became enamoured of the teachings of Hippocrates.

Other physicians of the day were beginning to study anatomy, but Paracelsus felt one could learn nothing from the dead. He was convinced that the only way to learn about illness was by studying the living body. He also valued what he could learn from healers, and between 1510 and 1524, he traveled throughout Europe, Russia, and the Middle East, where he absorbed the information shared with him by barber-surgeons, midwives, and folk healers.

Eventually, he acquired a background in medical science and chemistry of the time, and he also learned about the occult, astrology, and alchemy.

His study of alchemy under Islamic chemists led him away from plant-based mixtures that were popular at the time, and Paracelsus introduced the idea that medicines could be mixed from other compounds. This made him the pioneer of chemical medicine in Europe. He used the principles of alchemy—the extraction of pure metals from ores, the production and use of powerful solvents, evaporation, precipitation, and distillation—to make medications. In combination with plant extracts, he mixed arsenic, lead, sulphur, copper, sulphates, zinc, mercury, and antimony. He learnt that these metals could also be poisonous, and he noted that the secret was in the dosage. This work paved the way for a more serious application of chemistry to medicine[326].

[326] Kelly, K. (2010), p.9

A constant learner, Paracelsus realized that there was no better opportunity to observe the human body under stress than on the battlefield. He had learned enough surgery that he felt qualified to follow the Habsburg armies that were fighting in Italy and Scandinavia to provide care. As he helped manage the soldiers' wounds, he began to understand that infection was often the ultimate villain in taking the lives of the wounded young men. During this time, the treatment of choice for injuries sustained in battle often involved covering the wounds with boiling oil, dung, and other substances. Infection was often the result. Paracelsus saw the senselessness of what was being done, so he came up with a substitute theory that he hoped would divert the surgeons. He suggested that the concocted mixture should go on the weapon that caused the wound, and, in so doing, this treatment would be curative. Paracelsus's theory proved helpful. The soldiers' wounds were cleaned and then left to self-heal. Because the mixtures used were so inappropriate for wound care, this method was far preferable to putting these misunderstood agents directly onto the wounds.

Paracelsus was the first to step away definitively from Galen's theories, and in the process, he made significant contributions to medicine. He followed Hippocrates' observation-based medicine, believing that each disease was a separate entity that resulted from agents outside the body that could be cured with a treatment that addressed those symptoms, and that caused him to reject Galen's humoral balance theory.

2.2. Vesalius

Beginning in the 16th century, the study of anatomy became an important foundation for Western medicine. After the laws changed in 1537 and autopsies were permitted on an as needed basis, the physicians of the day were able to study human anatomy more regularly.

Vesalius was the first to see that Galen's understanding of anatomy was in large measure wrong. His medical education began at the University of Louvain, followed by a move to the University of Paris in 1533. At this stage, Vesalius noted the differences, and he began to speak openly about his disagreements with Galen's theories and those who taught them unquestioningly. Vesalius eventually moved on to the University of Padua to complete his studies and was offered a professorship there. Vesalius continued to perform more and more animal and human dissections, and he began to notice that some of Galen's notes were true for apes and monkeys but that human skeletons did not have the same features[327].

He realized that Galen must have been dissecting monkeys and assumed that what he found on an ape or a monkey would hold true for humans, too. Over time, Vesalius began a full-scale assault on Galen. Vesalius arranged to conduct a side-by-side comparison for the public in Padua, dissecting an ape on one table and a human on the other. He pointed out more than 200 differences between the two skeletons. In 1543, Vesalius published *De humani corporis fabrica* in an effort to inform a wider audience of his findings. At the time, this was the most accurate book on human anatomy.

Vesalius was joined by several others who helped clarify the understanding of anatomy. Miguel Serveto, a theologist and physician, correctly explained pulmonary circulation, but his work was never widely acknowledged. Gabriele Falloppio (Falopius), one of Vesalius's students, succeeded him as a professor of anatomy at Padua, where he continued to explore the body's structure and made notable advances in the study of the skull, the ear, and the female genitalia. Vesalius also inspired others to more closely study the organs and how the body worked. Another who did so was Bartolomeo Eustachio (1520–74), who discovered the Eustachian tube, the supra-renals, the thoracic duct, and the abducens nerve[328].

[327]Kelly, K (2010*), The Scientific Revolution and Medicine 1450-1700* p.23

[328]Ibid, p.38

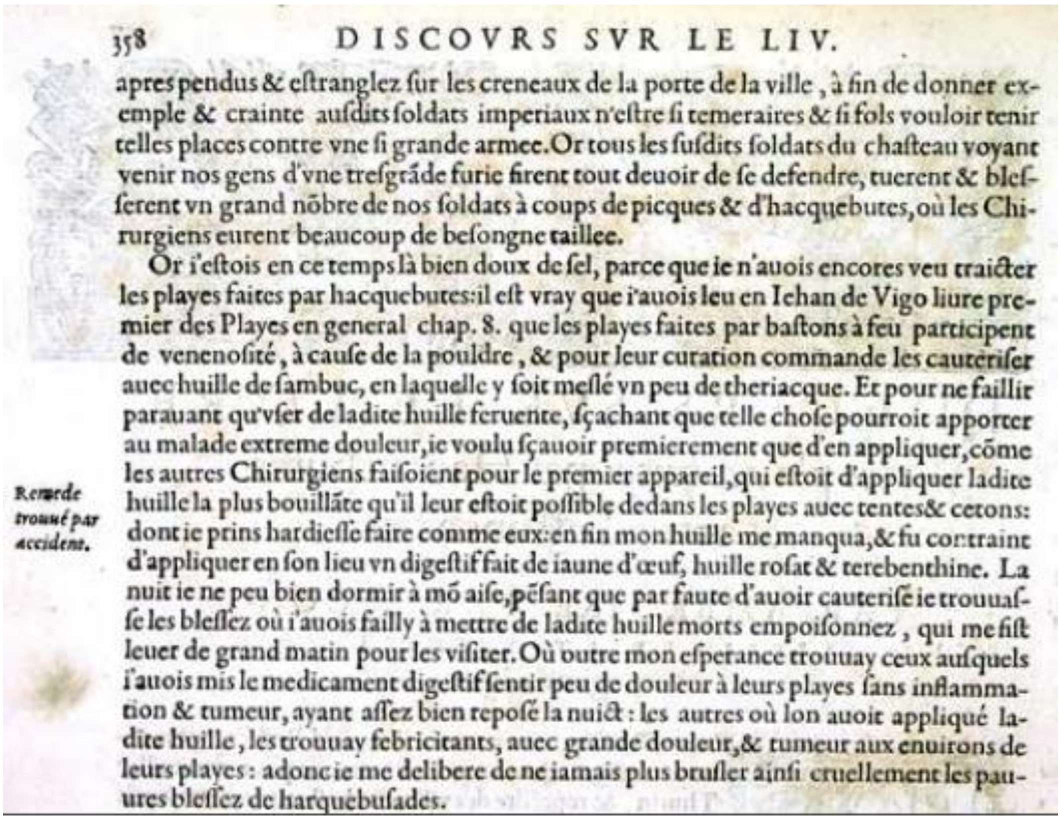
2.3. Ambroise Paré

In 1537, France was at war with the Holy Roman Emperor, Charles V, for the third time. The French expedition into Piedmont went to relieve the siege of Turin and occupy territory whose title was disputed by François I, the French king. The commander of the French infantry sent into northern Italy was the Marshal de Montejan, and he was accompanied by a young French surgeon, Ambroise Paré.

Paré was about 27 years old and had recently been practicing as a surgeon in the Hôtel Dieu in Paris. He had not yet been 'sworn' (registered) as a surgeon; still less did he have any academic qualifications. His origins were relatively humble and he could read neither Greek nor Latin.

The principal authority on the treatment of gunshot wounds, which were a relatively new type of injury, was Giovanni da Vigo (1450?–1525), surgeon to Pope Julius II. Vigo believed that gunshot wounds are poisoned by the effects of the gunpowder and so present particular difficulties in treatment. He instructed that gunshot wounds must be cauterized with hot oil to prevent the patient being poisoned[329].

[329] Donaldson IML (2004). Ambroise Paré's accounts of new methods for treating gunshot wounds and burns. *JLL Bulletin: Commentaries on the history of treatment evaluation*(*https://www.jameslindlibrary.org/articles/ambroise-pares-accounts-of-new-methods-for-treating-gunshot-wounds-and-burns/*).Accessed in june 2020.



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apres pendus & eſtranglez ſur les creneaux de la porte de la ville , à fin de donner exemple & crainte auſdits ſoldats imperiaux n'eſtre ſi temeraires & ſi fols vouloir tenir telles places contre vne ſi grande armee. Or tous les ſuſdits ſoldats du chaſteau voyant venir nos gens d'vne treſgrãde furie firent tout deuoir de ſe defendre, tuerent & bleſſerent vn grand nõbre de nos ſoldats à coups de picques & d'hacquebutes, où les Chirurgiens eurent beaucoup de beſongne taillee.

Or i'eſtois en ce temps là bien doux de ſel, parce que ie n'auois encores veu traicter les playes faites par hacquebutes: il eſt vray que i'auois leu en Iehan de Vigo liure premier des Playes en general chap. 8. que les playes faites par baſtons à feu participent de venenoſité, à cauſe de la pouldre, & pour leur curation commande les cauteriſer auec huille de ſambuc, en laquelle y ſoit meſlé vn peu de theriacque. Et pour ne faillir parauant qu'vſer de ladite huille feruente, ſçachant que telle choſe pourroit apporter au malade extreme douleur, ie voulu ſçauoir premierement que d'en appliquer, cõme les autres Chirurgiens faiſoient pour le premier appareil, qui eſtoit d'appliquer ladite huille la plus bouillãte qu'il leur eſtoit poſſible dedans les playes auec tentes & cetons: dont ie prins hardieſſe faire comme eux: en fin mon huille me manqua, & fu contraint d'appliquer en ſon lieu vn digeſtif fait de iaune d'œuf, huille roſat & terebenthine. La nuit ie ne peu bien dormir à mõ aiſe, pẽſant que par faute d'auoir cauteriſé ie trouuaſſe les bleſſez où i'auois failly à mettre de ladite huille morts empoiſonnez, qui me fiſt leuer de grand matin pour les viſiter. Où outre mon eſperance trouuay ceux auſquels i'auois mis le medicament digeſtif ſentir peu de douleur à leurs playes ſans inflammation & tumeur, ayant aſſez bien repoſé la nuict: les autres où lon auoit appliqué ladite huille, les trouuay febricitants, auec grande douleur, & tumeur aux enuirons de leurs playes: adonc ie me delibere de ne iamais plus bruſler ainſi cruellement les pauures bleſſez de harquebuſades.

Remede trouué par accident.

Figure 12: Paré A (1575) Les oeuvres de M. Ambroise Paré conseiller, et premier chirurgien du Roy avec les figures & portraicts tant de l'Anatomie que des instruments de Chirurgie, & de plusieurs Monstres.

Translation

"*Now, at that time I was very inexperienced because I had not yet seen the treatment of wounds made by the arquebus; it is true that I had read in the first book of Jean de Vigo about wounds in general, chapter 8, that wounds made by firearms are poisoned because of the powder and for their cure he commands that they be cauterized with oil of elderberry to which a little treacle should be added. Not to fail in the use of this burning oil and knowing that such treatment could be extremely painful for the wounded, I wanted to know before I used it how the other surgeons carried out the first dressing; this they did by applying the said oil as nearly boiling as possible to the wounds using lints and setons so I plucked up courage to do likewise.*

At last I ran out of oil and was constrained to apply a digestive made of egg yolk, oil of roses and turpentine. That night I could not sleep easily thinking that by the default in cautery I would find the wounded to whom I had failed to apply the said oil dead of poisoning; and this made me get up at first light to visit them. Beyond my hopes I found those on whom I had put the digestive dressing feeling little pain from their wounds which were not swollen or inflamed, and having spent quite a restful night. But the others, to whom the said oil had been applied, I found fevered, with great pain and swelling around their wounds.

From then I resolved never again so cruelly to burn poor men wounded with arquebus shot[330]."

Paré's observation that avoiding cauterization of gunshot wounds is not only better because it greatly reduces the patients' suffering, but is also less damaging, is striking enough in itself; but, in the context of its time, the use he made of his observation is even more remarkable. Paré was a young surgeon with no formal qualifications who was not even registered as one of the least prestigious of the medical practitioners, the barber-surgeons. That he dared to publish his experience when it flatly contradicted the established academic authority on the subject must have required not only remarkable self-confidence, but a good deal of courage.

Paré's large measure of common sense, acute observation, compassion and the courage and confidence to be persuaded by his own observations of the errors of authority and of popular belief, shine out from his writings and were not disregarded in his own time. From his humble beginnings he became surgeon-in-chief to three kings of France and the most famous surgeon of his generation[331].

[330]Translation by IML Donaldson

[331]Donaldson, (2004)

2.4. Bartolomé Hidalgo de Agüero

Before the 15th century, the Galenic tradition in the treatment of wounds promoted an approach called healing by 'second intention', which involved encouraging the development of 'laudable pus'. Laudable pus was pus with a creamy consistency which, by comparison with thin, smelly pus, was believed to reflect a 'worthy' response by the body to infection. Surgeons promoted this approach to treatment by forcing wounds open with instruments such as trephines or scrapers, applying emollient compounds, and encouraging drainage. The expectation was that wounds would heal only gradually under this regimen; however, patients subjected to it not infrequently died.

By the end of the 15th century some European surgeons were beginning to experiment with alternative methods. For example, partly by observation of 'natural' experiments andpartly asa result of formal experimentation, a Spanish contemporary of Ambroise Paré – Bartolomé Hidalgo de Agüero (1531–1597) – also challenged the traditional, 'wet healing' approach to the management of wounds. He developed, described and evaluated 'dry healing' of wounds, 'by first intention'[332]. His method involved cleaning the wound with white wine, bringing the wound edges together, removing any damaged tissue, applying astringent or drying compounds, and then covering the wound with a bandage[333].

Bartolomé Hidalgo de Agüero was born in Sevilla, and lived and died there. He studied medicine and surgery at the Hospital del Cardenal de Sevilla that was already

[332]Hidalgo de Agüero B (1604). *Thesoro de la verdadera cirugía y vía particular contra la común. Sevilla: Francisco Pérez, p. 67-68.*Cited in Solis (2011)

[333] Solis C (2011). Bartolomé Hidalgo de Agüero's 16th century, evidence-based challenge to the orthodox management of wounds. *JLL Bulletin: Commentaries on the history of treatment evaluation (https://www.jameslindlibrary.org/articles/bartolome-hidalgo-de-agueros-16th-century-evidence-based-challenge-to-the-orthodox-management-of-wounds/*) accessed in june 2020.

renowned for the treatment of wounds. The standard approach, taught to Hidalgo was the Galenic 'wet healing' method. After a while, however, Hidalgo observed that, out of every 30 patients treated, 24 or more died[334]. These observations prompted him to notice a passage in Galen's *Ad Glauconem de medendi methodo*, where the Roman 'wet healing' approach had been compared to the 'dry approach' implemented by physicians 'in Asia'[335].

Following up on this clue, probably over the years 1580 to 1583, Hidalgo developed the 'dry treatment' technique for managing wounds, and evaluated his results with a quantitative comparison with results following the wet method.

According to Hidalgo, the mortality rate of patients treated with 'the dry method' was around 3%, compared with over 50% with 'the wet method'[336]. Out of the 456 wounded patients admitted to the hospital in 1583, only 20 died (and of 57 patients admitted with head wounds over a two month period only 7 died).

3. The Evaluation of Bloodletting

Galenic medicine still held sway in the seventeenth century, hallowed by centuries of practice and universally taught in the European Medical Schools. Among at least some physicians there was undoubtedly dissatisfaction with the frequent ineffectiveness of treatment devised according to even the best of the learned tradition of the Schools of medicine.

An alternative was available. In the 16th century, Paracelsus rejected the Galenic system and preached an 'alchemical' alternative. In the later years of the 16th century and throughout much of the 17th, the Galenists – especially those in Paris which had

[334]Chinchilla A (1845). *Bartolomé Hidalgo de Agüero. Anales Históricos de la Medicina en General y biográfico-bibliográfico de la española en particular. Valencia*. Don José Mateu Cervera, Vol II, p. 28-39.
[335]Kühn KG, ed (1825). *Claudii Galeni opera omnia*. Vol. X, Leipzig: Car. Cnoblochii, pp 454-455.
[336]Herrera Dávila J (2010). El Hospital del Cardenal de Sevilla y el Doctor Hidalgo de Agüero. Sevilla : Ediciones de la Fundación de Cultura Andaluza, p 94, p226.

become the citadel of the 'new' Galenism since the 1530s – did battle with the new chemical doctors, the *iatrochemists*[337]. They were often labelled Paracelsians – though by no means all of them accepted the theories of Paracelsus, who prescribed remedies derived largely from metals and other minerals. Some physicians relied entirely on the 'chemical' remedies, others used both the Galenic and iatrochemical *materia medica*.

Baptista van Helmont was a 17th century physician influenced by Paracelsian thinking and practice. He studied various disciplines at the University of Louvain, including medicine.

Having read all the extant great medical works – some six hundreds of them – he found them them all completely unsatisfactory and devoid of any certain knowledge of truth[338].

Helmont was undoubtedly influenced in developing his new system of medicine by the ineffectiveness of Galenic practice – though by no means only by this consideration. His aim was, indeed, a new medicine, not a return to, nor perfection of, the medicine of some previous golden age.

The title of the *Ortus Medicinae*[339] translates as: '*The rise of Medicine. That is, the beginning of a physic never before known. The advance of a new medicine to be revenged on diseases and for a long life ….*'

In his book, van Helmont challenged the "orthodox" medicine to a trial on the use of bloodletting and purging. This 3000 years old practice continued throughout

[337]Debus AJ (1991). The French Paracelsians. Cambridge: Cambridge University Press.

[338]Donaldson IML (2016). van Helmont's proposal for a randomised comparison of treating fevers with or without bloodletting and purging. *JLL Bulletin: Commentaries on the history of treatment evaluation (https://www.jameslindlibrary.org/articles/joan-baptista-van-helmonts-proposal-around-1643-for-a-randomised-comparison-of-using-or-withholding-bloodletting-and-purging-when-treating-fevers/*) accessed in june 2020.

[339]Helmont JB van (1648*). Ortus medicinæ. Id est, initia physiciæ inaudita. Progressus medicinæ novus, in morborum ultionem, ad vitam longam* /Published by Francisco Mercurio van Helmont

the renaissance era as a treatment for diseases such as hypertension, apoplexy, dropsy, and, nervous disorders may have hadmore of a physiologic explanation. This ancient practice was notformally questioned until the seventeenth century.

Van Helmont's *Ortus Medicinae* summarizes some aspects of the basis of the quarrel which is, of course, a disagreement about the nature of Nature itself and the manner in which disease arises; the argument centres on the treatment of fevers as an exemplar of general principles.

'*Author provocat Humoristas, totius mundi, in certamen actuale*.'

The author challenges the Humorists (i.e. the Galenists) of the whole world to a practical contest.

For Medicine is no empty word, no fool's boast, no vain speech: after the word is said the work remains to be done. In this matter I scorn abuse, the boasts of the ambitious and pitiful vanities.

Come, let us return to the argument. If you speak the truth, you Schoolmen, that you are able to cure any kind of fever without purging but that you are not willing to do so for fear of a worse relapse, come down to a contest, you believers in the Humours. Let us take from the itinerants' hospitals, from the camps or from elsewhere 200 or 500 poor people with fevers, pleurisy etc. and divide them in two: let us cast lots so that one half of them fall to me and the other half to you. I shall cure them without blood-letting or perceptible purging, you will do so according to your knowledge (nor do I even hold you to your boast of abstaining from phlebotomy or purging) and we shall see how many funerals each of us will have: the outcome of the contest shall be the reward of 300 florins deposited by each of us. Thus shall your business be concluded… Let there be a real debate to find the means of cure…. Let words and quarrelling cease; let us act in friendship and from our shared experiences; let it be known hereafter which the true method is. For when there is contradiction, *of the two proposals only one is true. For if you are moved by charity, or the care of your souls vexes you, let us proceed to the challenged contest! For I swear that if you win I shall happily abandon my evil opinions and hereafter enter fully into your doctrine.*[340]

Since the challenge was issued in a work that was first published in 1648 when Helmont had been dead for more than three years he could not have taken part in any trial resulting from the publication[341].

French physicians were also evaluating bloodletting in a more scientific approach versus a dogmatic approach. Most prominent among these was Pierre Charles-Alexandre Louis (1787-1872), known for his application of ''*la méthode numérique*'' [the numerical method][342] to assess the effects of bloodletting. His findings were reported in greatest detail in his 1835 monograph''*Recherches sur les effets de la saignée*'' [Research on the effects of bloodletting]. There was no prospective element in Louis ''method, 'however. It consisted of retrospective analyses of case series derived from both his own practice and hospital records, using simple tabular presentations and calculation of average mortality rates[343].

Not long after, a young contemporary of Louis, Jules Gavarret, took a step closer to present-day concepts of the proper use of statistical methods for assessing the results of treatment. Gavarret was born in 1809 and served for a few years as an artillery lieutenant in the French Army, but he resigned his commission in1833 to begin scientific studies with Gabriel Andral (1797-1876), an eminent Parisian physician who pioneered studies of blood chemistry. Gavarret published his findings

[340]Helmont 1648; *Ortus*, pp 526-527.Translation by IML Donaldson

[341] Donaldson, (2016)

[342] Louis P. (1836*) Researches on the effects of blood-letting in some inflammatory diseases, and on the influence of tartarised antimony and visication in pneumonitis*. Am. J. Med. Sci.;18:102–111

[343]Claridge and Fabian, (2005) *History and Development of Evidence-based Medicine*

in 1840 in his *Principes Générale de Statistique Médicale* [General Principles of Medical Statistics][344], in which he also drew attention to the problems likely to arise from attempts to compare specific treatments in two groups of patients who might differ in respect to factors such as economic and social circumstances, diagnostic criteria, and other features of treatment.

III- The Numerical Approach Assessing Medical Interventions

The British medical literature contained many discussions of the need to document diseases and their treatments using numerical data derived from patients seen in civilian and military practice[345]. Beginning in the 1720s, numerical methods were used to compare mortality after smallpox inoculation (variolation) with mortality after natural smallpox, in Britain, and in other parts of Europe, and in America[346]. Throughout the 18th century, writers prepared detailed numerical reports of their work and experience, and emphasized the need to use this

type of information. They insisted on the need not only for regularly kept summaries of patient records and for mass observation, but also for numerical analysis of these data. While the first group clearly thought about what they were doing, the others may just have fallen in line with what was becoming the empirical tradition, or, later in the 18th century, may have used numerical data simply because, by then, this was “what was done”[347]. Numerical data were sometimes reported only

[344]Gavarret (1809-1890). In: *The James Lind Library (www.jameslindlibrary.org)* Accessed February, 2020

[345]Tröhler U (2010). The introduction of numerical methods to assess the effects of medical interventions during the 18th century: a brief history. *JLL Bulletin: Commentaries on the history of treatment evaluation (https://www.jameslindlibrary.org/articles/the-introduction-of-numerical-methods-to-assess-the-effects-of-medical-interventions-during-the-18th-century-a-brief-history/)* accessed in June 2020.

[346]Rusnock A (2002). *Vital accounts: quantifying health and population in eighteenth century England and France*. Cambridge: Cambridge University Press, chaps. 2-4.

[347]Tröhler, U. (1978). *Quantification in British medicine and surgery 1750-1830*, with special reference to its introduction into therapeutics. PhD Thesis, University of London.

in texts. From early in the 18th century, however, data were increasingly also being presented in tables, beginning with results of smallpox inoculation[348]; The smallpox inoculation issue was probably the key to the use of what was later called the numerical method, that is, counting and comparing, as this appealed not only in Britain but was also used on the continent and in America[349].

In addition to these and other causal inferences about the effects of treatment comparisons based on retrospective analyses of numerical data, there are also examples based on prospective experiments. James Lind's account of his comparison of six treatments for scurvy is probably the best known of these[350].

1. Thomas Nettleton and James Jurin:

1.1. Nettleton

Thomas Nettleton (1683-1742) was one of the first, and possibly the first to use quantitative assessments of the effects of medical interventions. Prior to establishing a medical practice in Halifax, West Yorkshire, Nettleton had been educated at Bradford Grammar School, and had studied medicine at Edinburgh and Leyden, where he was awarded his Doctorate of Medicine. In December 1721, during an epidemic of smallpox in West Yorkshire and frustrated by the lack of any effective therapy for the disease, Nettleton began to use variolation, which at the time was

[348]-Nettleton, T. (1722). Part of a letter from Dr. Nettleton, physician at Halifax, to Dr. Jurin, R.S. Secr. Concerning the inoculation of the smallpox, and the mortality of that distemper in the natural way.*Philosophical Transactions of the Royal Society of London.* 32:209-212.

[349]Huth, E.J. (2006). Benjamin Franklin's (1706-1790) place in the history of medicine. *JLL Bulletin: Commentaries on the history of treatment evaluation (https://www.jameslindlibrary.org/articles/benjamin-franklins-1706-1790-place-in-the-history-of-medicine/).*Accessed in june 2020.

[350]Lind, J. (1753*). A treatise of the scurvy. In three parts. Containing an inquiry into the nature, causes and cure, of that disease. Together with a critical and chronological view of what has been published on the subject.* Edinburgh: Printed by Sands, Murray and Cochran for A Kincaid and A Donaldson.

known as inoculation[351]. Variolation to immunize people against smallpox was introduced into Europe and North America in 1721[352]. However, there was uncertainty and debate about whether it did more good than harm. To address this uncertainty, Nettleton collected statistics on the mortality associated with naturally-acquired smallpox and compared these with mortality following variolation. He communicated his findings in a series of letters and a pamphlet published in 1722 and 1723[353].

1.2. Jurin

James Jurin (1684-1750) was an 18th century physician and polymath[354]. As a scholar at Trinity College, Cambridge, he became acquainted with the work of Sir Isaac Newton, of which he became an enthusiastic advocate. He practiced medicine while continuing to develop his interest in science and mathematics, corresponding with many of Europe's leading scientists[355].

2. Variolation in Britain

Smallpox, whether epidemic or endemic, was a prominent cause of death in 18th century England. Data from that period indicate deaths from smallpox averaged

[351] Boylston, A.W. (2010). Thomas Nettleton and the dawn of quantitative assessments of the effects of medical interventions. *JLL Bulletin: Commentaries on the history of treatment evaluation (https://www.jameslindlibrary.org/articles/thomas-nettleton-and-the-dawn-of-quantitative-assessments-of-the-effects-of-medical-interventions/)* accessed in june 2020.

[352]Huth, E.J. (2005). Quantitative evidence for judgments on the efficacy of inoculation for the prevention of smallpox: England and New England in the 1700s *(https://www.jameslindlibrary.org/articles/quantitative-evidence-for-judgments-on-the-efficacy-of-inoculation-for-the-prevention-of-smallpox-england-and-new-england-in-the-1700s/).*Accessed in june 2020.

[353]Rusnock A (1996). *The Correspondence of James Jurin (1684-1750) Physician and Secretary to the Royal Society*. Amsterdam: Editions Rodopi B.V.

[354]Rusnock, A.(2004). Jurin, James (bap. 1684, d. 1750). In: *Oxford Dictionary of National Biography*. Oxford University Press. Online edn, Jan 2008 http://www.oxforddnb.com/view/article/15173, accessed June 2020.

[355]Bird, A. (2018). James Jurin and the avoidance of bias in collecting and assessing evidence on the effects of variolation. *JLL Bulletin: Commentaries on the history of treatment evaluation (https://www.jameslindlibrary.org/articles/james-jurin-and-the-avoidance-of-bias-in-collecting-and-assessing-evidence-on-the-effects-of-variolation/)* accessed in June 2020.

roughly 10% as a percentage of all deaths in affected regions but sometimes up to approximately 20%. Greatly feared squeals were severe disfigurement or blindness[356].

Variolation was the practice of inoculating a person, usually a child, with pus or scab from a smallpox blister to give them a mild case of smallpox. That gave protection against potentially fatal naturally occurring smallpox thereafter. In the early eighteenth century this practice was referred to as (smallpox) inoculation, but later became known as 'variolation' to distinguish it from Jenner's inoculation using cowpox ('vaccination') in 1796.

The practice of variolation in Europe begins with its importation from the Middle East by a Scottish surgeon, Charles Maitland, who accompanied Lady Mary Wortley Montague, her diplomat husband and their children to Constantinople[357]. Lady Mary discovered that variolation was widely practiced in Turkey and that it was considered safe and effective in preventing fatal smallpox. She had her son inoculated by an old Greek practitioner, assisted by Maitland.

In April 1721, back in England, Maitland was asked by Lady Mary to inoculate her daughter. Maitland agreed, but insisted on observers, one of whom, John Keith, a physician, immediately asked Maitland to inoculate his sole surviving son[358].

Impressed by the mild inoculated smallpox and complete recovery of the two children, a group of physicians approached King George I with a request to expand this initial experience by experimenting on condemned prisoners. After being promised a complete pardon for their crimes, six prisoners confined at Newgate agreed to be inoculated[359]. In August 1721, observed b several members of the Royal

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[356]Huth, E.J. (2005)

[357]Miller, G. (1957). *The adoption of inoculation for smallpox in England and France*. Philadelphia: University of Pennsylvania Press.

[358]Boylston, A.W. (2010)

[359]Sloane H (1756). An account of inoculation by Sir Hans Sloane, Bart. … *Philosophical Transactions of the Royal Society of London* 49:516-20.

Family, various apothecaries, surgeons, and Fellows of the Royal Society and College of Physicians, Maitland variolated the six prisoners. Five of them developed mild, distinct smallpox; one did not develop any pustules and subsequently admitted that he had had smallpox six months before. In February 1722, Maitland published his account of the Newgate experiment[360], and conducted two further trials on parish orphans[361].

Maitland's early trials of variolation in Britain were intended to demonstrate its relative safety and the mild resulting smallpox, and they led to a decision in April 1722 to inoculate two daughters of the Prince of Wales, the future George II. Although the princesses suffered no ill effects, news of two deaths following variolation in Britain and others in Boston led to an intense debate about the safety and advisability of the procedure.

3. Comparing mortality

Just before the princesses had been inoculated, a letter from Thomas Nettleton to William Whitaker – a friend in London – revealed that he had inoculated over forty individuals in the parish of Halifax, with no deaths and only a few cases of severe disease.[362]Nettleton's letter was read to the Royal Society on 17 May 1722, and a correspondence ensued between Nettleton and James Jurin, the mathematically inclined secretary of the Royal Society. Jurin invited him to submit his letter to Whitaker

[360]Maitland C (1722). *Mr. Maitland's account of inoculating the small pox*. London: Printed by J. Downing

[361]Miller G (1957). *The adoption of inoculation for smallpox in England and France*. Philadelphia: University of Pennsylvania Press. p88-89

[362]Nettleton T (1722). An account of inoculating the small pox; in a letter to Dr. William Whitaker. London: S Palmer for J Batley, at the Dove in Pater-Noster Row.

for publication in the Philosophical Transactions, and asked for any further experience of inoculation that Nettleton might have[363].

Jurin decided to embark on his own study of the value of variolation, and particularly its safety. Was an individual who underwent variolation more or less likely to die than one who did not and so who risked a natural infection?

It was clear to Jurin, as it had been to Nettleton, that what was needed was more information about the number of those who had been variolated and the proportion of those who died, along with data on mortality from natural smallpox—as Nettleton noted in his letter '*I am very sensible you will require a great number of Observations, before you can draw any certain Conclusions.'*[364]

Jurin was perfectly placed, intellectually and socially, to undertake such an investigation, since he was both a doctor and a mathematician and was well connected through his role in the Royal Society. He used his position to solicit information from across Britain about individuals who had been inoculated with smallpox. Jurin specified the details that he required (name, age, manner of inoculation; whether the inoculation was successful in producing smallpox, and if so after how long; whether the patient survived or died; and so on)[365].

On 17 January 1723, Jurin read his own paper, citing Nettleton and information from a few other inoculators[366]. His paper was mostly well received, but it was

[363]Boylston AW (2010). Thomas Nettleton and the dawn of quantitative assessments of the effects of medical interventions. *JLL Bulletin: Commentaries on the history of treatment evaluation (https://www.jameslindlibrary.org/articles/thomas-nettleton-and-the-dawn-of-quantitative-assessments-of-the-effects-of-medical-interventions/)* accessed in June 2020.
[364]Nettleton, T. (1722). Part of a letter from Dr. Nettleton, physician at Halifax. To Dr. Jurin R.S. Secr. Concerning the inoculation of the small pox, and the mortality of that distemper in the natural way. *Philosophical Transactions*. 32:209-212.
[365]Bird, A. (2018). James Jurin and the avoidance of bias in collecting and assessing evidence on the effects of variolation. *JLL Bulletin: Commentaries on the history of treatment evaluation (https://www.jameslindlibrary.org/articles/james-jurin-and-the-avoidance-of-bias-in-collecting-and-assessing-evidence-on-the-effects-of-variolation/)* accessed in June 2020
[366]Miller, G. (1957). *The adoption of inoculation for smallpox in England and France*. Philadelphia: University of Pennsylvania Press. p.115

criticized by Isaac Massey[367], apothecary to Christ's Hospital. Massey's point was that the comparison between inoculated and natural smallpox was unfair because many patients with natural smallpox might have survived if they had been given the same medical support as those who were inoculated. Also many patients with natural smallpox who had died were unwell from other diseases whereas inoculated individuals were usually in good health. Massey suggested that:

…not above One in Forty that have the Small Pox, would die of that Distemper, if treated with equal Care with those that are inoculated: but to form a just Comparison, and calculate right in this Case, the Circumstances of the Patients, must and ought to be as near as may be on a Par.[368]

Jurin notes the controversy surrounding inoculation and claims that his aim is simply to furnish the facts relevant to the debate in an impartial way. He does indeed provide the data in as objective a manner as possible. It is nonetheless clear that Jurin regards the case for inoculation as very strong. Jurin's aim was to gather and present data to quantify three risks: (i) the risk of death due to inoculation among people who are inoculated; (ii) the risk of death from natural smallpox among un-inoculated people; (iii) the risk of death among people who contract natural smallpox[369].

Jurin showed that 2,351 patients out of 14,559 with natural smallpox had died (16 per cent), while only 9 of 440 individuals successfully inoculated had succumbed (2 per cent)[370]. In his analysis of the information, Jurin sensibly decided to count all deaths following inoculation as due to inoculation, regardless of the opinions of

[367]Massey, I. (1723). A short and plain account of inoculation. With some remarks on the main argument made use of to recommend that practice, by Mr. Maitland and others. To which is added, a letter to the learned James Jurin, M.D.R.S. Secr. Col. Reg. Med. Lond. Soc. In answer to his letter to the learned Dr. Cotesworth, and his comparison between the mortality of natural and inoculated small pox. The second edition. London: W. Meadows.

[368]Bird, A. (2018).

[369]Ibid

[370]Jurin, J. (1727). An account of the success of inoculating the small-pox in Great-Britain, for the year 1726. With a comparison between the miscarriages in that practice, and the mortality of the natural small-pox . . . London: J. Peele.

observers of individual cases about the cause of death. This dealt with possible observer bias in deciding whether a death was really due to inoculated smallpox. Jurin also avoided another potential pitfall by counting only deaths, thereby avoiding subjective debates about the degree of severity of individual cases. Finally, Jurin acknowledged that, before it would be possible to know for certain that inoculation always conferred immunity to smallpox, it would: "require a considerable time and a much greater Number of Experiments than have yet been made."[371]

Thus it was that the correspondence between Thomas Nettleton and James Jurin during the winter of 1722/23 led to judgments about the effects of variolation being based not on impressions from a few cases or indirect arguments from past figures, but rather on comparisons of unambiguous outcomes (deaths) among large numbers of inoculated people, and among others who had contracted smallpox naturally[372].

4. Avoiding bias

Biases occur when researchers or their methods are disposed to treat the evidence in such a way that is not conducive to the truth. Bias in the assessment of a healthcare intervention can be especially problematic, because the evidence is often unclear; because there are entrenched opinions; because healthcare is related to other social and economic matters; and because health and disease are emotive issues. All these were present in the assessment of variolation. It was not always obvious whether an inoculation had 'taken', producing a genuine case of smallpox, or whether the resulting case was a mild or severe one, or whether a death was caused by the variolation. This made the data especially susceptible to biased interpretation. Many

[371]Jurin, J. (1722/23). Letter to Thomas Nettleton dated 8 January, as cited in Rusnock 1996, p 123.
[372]Boylston AW (2010)

people had strong prior opinions on variolation, e.g. that it was attempting to interfere with the will of God, or that it was a suspicious foreign feminine practice. The idea of deliberately giving a child a case of smallpox was understandably alarming, and anxiety could turn to anger if the case was severe or led to death—the evidence of such cases would be far more salient than that of others. It was thus important for Jurin to avoid bias in his research. The avoidance of bias meant that he could rely on his results—he could know whether variolation was safer than the risk of natural smallpox; and it meant also that he could present results that would be persuasive to others[373].

4.1. Quantification

The work of Nettleton, Jurin, and on variolation seems to have been the first to use quantitative evidence to assess a medical intervention. Since the question concerned a comparison of risks, it could not be answered by a qualitative approach.

For example, because smallpox could scar or even blind those who survived a bad case, it was important that inoculation gave only mild cases of the disease (but genuine cases nonetheless). Many doctors held that the risk of a severe eruption could be reduced by the use of laxatives. Sir William Watson[374] (1768) undertook a series of experiments to test this hypothesis and also to test different types of material used in the inoculation[375]. But what counts as a 'severe' eruption could be different from an experiment to another depending on the severity standards of each experiments. To solve that problem, Watson eschewed qualitative assessment in favor of counting

[373]Bird A (2018)

[374]Watson W (1768). *An Account of a Series of Experiments instituted with a view of ascertaining the most successful method of inoculating the smallpox*. London: J. Nourse.

[375]Boylston AW (2008). William Watson's use of controlled clinical experiments in 1768. *JLL Bulletin: Commentaries on the History of Treatment Evaluation. https://www.jameslindlibrary.org/articles/william-watsons-use-of-controlled-clinical-experiments-in-1767/.* Accessed in June 2020.

the number of smallpox pustules, thereby ensuring comparability of cases while also reducing the room for observer bias.

4.2. Tables

Jurin was clear in writing to his correspondents that he required information concerning all those inoculated, thereby avoiding bias arising from the selective use of data. The principal results of this research were laid out in tables to permit easy calculation of the risks in question. Tables have many advantages, such as the concise and easily accessible presentation of information. When tables present the collation of numerical data as evidence in the assessment of interventions, they have the further important benefit of reducing the danger of bias. A table helps avoid confirmation bias, whereby people focus only on evidence supporting an already favored hypothesis, ignoring counter-evidence. And it avoids bias from the availability heuristic, whereby people form judgments about a complex matter on the basis of evidence that comes easily to mind (dramatic, or recent events, etc.). Presented in summary tabular form, no case exerts more influence on the conclusion than any other; in presenting all the available data, 'unfavorable' data are as likely to be included as favorable data.

4.3. Transparency and open data

The presentation of data in tables does not eliminate all biases. The inoculators who sent their results to Jurin could have introduced biases in their reports. To minimize bias from this source, Jurin took care to obtain detailed case reports rather than just the numbers. This enabled him to make uniform judgments (e.g. as to whether an inoculation had succeeded in giving the patient smallpox). He even asked for names (which were not published) so that any controversial cases could be investigated later. Jurin advertised the fact that he retained all his original data, which would allow particular cases to be examined in more detail or to be followed up if necessary. This was important, for example, in finding out whether someone who had natural smallpox had previously been inoculated[376].

Imprecision, borderline cases, and uncertainty are especially liable to lead to bias. Jurin handled these by publishing the details of such cases so that readers could form their own judgments rather than rely on his. For example, it was not always clear whether a smallpox death following inoculation was due to that inoculation or due to a concurrent natural infection. So Jurin not only published the details of such cases but also produced tables that gave different risks depending on how many of the cases of smallpox one regarded as caused by the inoculation.

4.3.1. Blank forms

Another eighteenth century innovation that promoted the reliability of data and of the inferences drawn from them was the introduction of the blank form. A template, with headings and questions already printed and space for respondents to write in their observations, was particularly helpful where research required input from many collaborators. In his correspondence with inoculators, Jurin requested detailed case studies and had to follow up many reports for important missing information.

In 1723 Jurin pursued another project that aimed to relate weather and health. He gave his correspondents detailed instructions about the data they were to collect and how it was to be presented, along with a specimen form that they could copy.

The eighteenth century saw several developments that made the collection of evidence in clinical medicine more systematic and so less liable to bias and other forms of error that would undermine the reliability of inferences drawn from that evidence[377]. Jurin's work on variolation appears to have been the first example of the

[376] Bird A (2018)

[377] Tröhler, U. (2010). The introduction of numerical methods to assess the effects of medical interventions during the 18th century: a brief history. *JLL Bulletin: Commentaries on the history of treatment evaluation.https://www.jameslindlibrary.org/articles/the-introduction-of-numerical-methods-to-assess-the-effects-of-medical-interventions-during-the-18th-century-a-brief-history/.* Accessed in June 2020.

careful use of numerical data to assess a medical intervention. That work gave a reliable answer to the question of the relative safety of variolation compared with natural smallpox, an answer that could not have been gained by using a purely qualitative approach. An important reason why a qualitative approach is unable to give a reliable answer to questions such as this is that it is liable to bias (conscious or unconscious).

An important and distinctive feature of Jurin's work is the care he took to minimize particular sources of bias. Following Jurin, the use of numerical approaches and the avoidance of bias became well-established in medicine in eighteenth century Britain[378]. Jurin has a strong claim, it may therefore be argued, to have established clinical medicine as a science[379].

IV- Controlled Clinical Trials Era

1. James Lind's Scurvy Trial

Scurvy was an illness that had been around for a long time. The disease frequently presents with spots on the skin (mostly on the legs) and features bleeding from the mucous membranes and spongy gums, resulting in tooth loss. As the disease progresses, a victim's muscles become rubbery, making it hard to move around. It was recognized and described as early as Hippocrates, and it was widely reported in the 13th century among those who joined the Crusades[380]. In the 15th and 16th centuries, scurvy appeared again in a prominent way because of the increase in sea travel. Today, it is known that scurvy results from a deficiency of

[378]Tröhler, U. (2000). *"To improve the evidence of medicine" The 18th century British origins of a critical approach*. Edinburgh: Royal College of Physicians of Edinburgh.
[379]Bird, A. (2017). Systematicity, knowledge, and bias. How systematicity made clinical medicine a science. Synthese https://doi.org/10.1007/s11229-017-1342-y
[380]Kelly, K. (2010) *The Scientific Revolution and Medicine 1450-1700*, p.87

vitamin C, a vitamin that is easily obtained from fresh fruits and vegetables. Sailors embarking on voyages that might take one to two years could not carry much fresh food with them, so vitamin C deficiencies and scurvy abounded[381].

James Lind is considered the first physician to have conducted a controlled clinical trial of the modern era. He was born in Edinburgh on 4 October 1716. After his surgical apprenticeship in Edinburgh, Lind joined the Royal Navy in 1738 as a surgeons' mate. In 1740, during the War of the Austrian Succession, Lind joined the 50 gun vessel Salisbury[382].

During a ten-week absence from shore, 80 out of 350 sailors were struck down by scurvy, and Lind's prospective controlled experiment – in which he compared the relative merits of six treatments then in use for treating the disease in 12 patients – began on board on 20 May 1747.

Lind subsequently added to his first-hand experience in two ways: he searched for, abstracted and evaluated previous reports of the disease; and he drew on accounts sent to him by members of the Society of Naval Surgeons. In other words, he conducted a systematic review of what had been written on the topic by others.

Lind selected 12 ill sailors and divided them into groups of 2. All the subjects displayed similar symptoms. ("They all in general had putrid gums, the spots and lassitude, with weakness of knees," he wrote in his 1753 paper *A Treatise on the Scurvy*). Isolated from the rest of the crew, the men were given the same rations, but each pair received a different scurvy treatment: either cider, a few drops of a weak acid, vinegar, sea-water, nutmeg and barley water, or oranges and lemons. After 6 days, the ship's supply of fruit was spent, but by then it hardly mattered; the 2 men

381 Kelly, K. (2010) *The Scientific Revolution and Medicine 1450-1700*, p.87

382 Sutton G (2004). James Lind aboard Salisbury. *JLL Bulletin: Commentaries on the history of treatment evaluation (https://www.jameslindlibrary.org/articles/james-lind-aboard-salisbury/)* accessed in June 2020.

on the citrus treatment were already back on their feet. The others, to paraphrase Lind's description of their original condition, remained “weak in the knees”[383].

Lind judged his relatively small number of observations on twelve patients, reported in some detail, as convincing, particularly because the differences shown were so dramatic. Lind’s therapeutic findings made little impact on medical opinion in Britain: indeed, the year after their publication (1753) the Navy’s ‘Sick and Hurt Board’ rejected a proposal to provide sailors with supplies of fruit juice[384].

Lind’s experiment had not been based on pathophysiological theory, but rather “controlled empiricism”: He gave no reason for the choice of his possible treatments. His trial succeeded because one of the remedies contained Vitamin C. He knew how to perform a comparative experiment, well controlled for time and environment, but perhaps less well, which experiment he should do. Had it been based on theory, his work might have been more likely to receive credit with the medical establishment. On the other hand, it seems historically relevant to recognize that Lind was successful in promoting comparative clinical trials quickly, possibly even within the Sick and Hurt Board, whose lethargy has often been criticized. Besides the further trials with anti-scorbutics, the Board later also ordered trials of drugs against ‘fevers’. This was a new development and an application of the much-praised evidence-based medicine[385].

[383]Collier, R. (2009)”Legumes, lemons and streptomycin: A short history of the clinical trial”, in *CMAJ*, Vol 180 Jan 2009

[384]Tröhler, U. (2003). James Lind and scurvy: 1747 to 1795. *JLL Bulletin: Commentaries on the history of treatment evaluation (https://www.jameslindlibrary.org/articles/james-lind-and-scurvy-1747-to-1795/)* accessed in June 2020.

[385]Ibid

2. The Evolution of Methods to Control Biases

One of the commonest biases people go through daily is the Observer bias. It occurs mainly when people believe that they already 'know' the effect of a treatment, or some other kind of intervention. Observer biases can be reduced and sometimes abolished by masked assessment (often referred to as blind assessment). The devices for masking assessments of treatment – when possible, using a placebo (dummy) treatment as part of the comparison – allow comparisons to be made which are independent of any observer bias or preconceived 'knowledge'[386].

2.1. Masked assessment of treatment

The use of blind assessment and dummy controls was adopted in medicine during the early tug-of-war between orthodox medicine and 'irregular' healers[387]. Conventional physicians and scientists distrusted the claims of unconventional healers, which were often based on principles that were incompatible with orthodox beliefs. In order to demonstrate that these claims were illusions of the mind or imagined effects, conventional scientists introduced masked assessment. Quite understandably, unconventional healers quickly adopted the methodology to try to demonstrate that their interventions were indeed independent of their beliefs[388].

An example of a masked assessment was performed by a commission of inquiry appointed by Louis XVI in 1784 to investigate the medical claims made by Anton Mesmer about the effects of 'animal magnetism'. The commission, headed by Benjamin Franklin, consisted of such distinguished members as Antoine Lavoisier,

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[386] Kaptchuk, T.J. (2011). A brief history of the evolution of methods to control observer biases in tests of treatments. *JLL Bulletin: Commentaries on the history of treatment evaluation (https://www.jameslindlibrary.org/articles/a-brief-history-of-the-evolution-of-methods-to-control-of-observer-biases-in-tests-of-treatments/)* accessed in june 2020.

[387] Kaptchuk, T.J. (1998). "Intentional ignorance: a history of blind assessment and placebo controls in medicine." *Bulletin of the History of Medicine* 72:389-433.

[388] Ibid

Jean-Sylvain Bailly and Joseph-Ignace Guillotin. Their goal was to assess whether the purported effects of this new healing method were due to any 'real' force, or due to the 'illusions of the mind'. Among the many tests performed, blindfolded people were told that they were receiving or not receiving magnetism when in fact, at times, the reverse was happening. The people being studied felt the effects of mesmerism only when they were 'told' and felt no effects when they were not told, whether or not they were receiving the treatment. They were also given what we would now call placebo or dummy treatments of 'mesmerized water' and 'mesmerized trees'[389].

A few years later in 1800, and explicitly inspired by the French investigators, John Haygarth conducted a single blind experiment using a placebo (sham) device. He showed that a set of fake tractors made of wood achieved similar effects on the symptoms of rheumatism as the effects which had been attributed to `magnetic healing' using metal tractors, so called 'Perkinism'. Haygarth's study made clear that informal 'trials of therapy' can be plagued by false positives (due to placebo effects, physicians' and patients' desires to please, the pre-existing expectations of both parties, and natural history). And they can also result in false negatives (patients destined to deteriorate, and the intervention resulting in them remaining stable)[390].

At Guy's Hospital in London, William Withey Gull came to similar conclusions after treating 21 rheumatic fever patients 'for the most part with mint water'. It was not until much later, however, that a more skeptical attitude in mainstream medicine

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[389] Donaldson, (2005). Mesmer's 1780 proposal for a controlled trial to test his method of treatment using 'Animal Magnetism'. *JLL Bulletin: Commentaries on the history of treatment evaluation (https://www.jameslindlibrary.org/articles/mesmers-1780-proposal-for-a-controlled-trial-to-test-his-method-of-treatment-using-animal-magnetism/)* accessed in June 2020.

[390] Donaldson, (2016). Antoine de Lavoisier's role in designing a single-blind trial to assess whether 'Animal Magnetism' exists. *JLL Bulletin: Commentaries on the history of treatment evaluation (https://www.jameslindlibrary.org/articles/antoine-de-lavoisiers-role-in-designing-a-single-blind-trial-to-assess-whether-animal-magnetism-exists/)* accessed in June 2020.

led to a recognition that there was a need to adopt masked assessment and placebos to assess the validity of its own more 'scientific' (and therefore more 'reasonable') claims[391].

Masked assessment seems to have first entered the conventional medical world at the end of the nineteenth century, during the French hypnotism-suggestion debates. In a continuation of the earlier controversy about 'animal magnetism', newly `psychologized' forms of

Mesmerism- such as hypnotism, psychical research and suggestion – were frequently being subjected to well-publicized tests with masked assessment[392]

2.2. Alternation and Random Allocation

At the beginning of the 19th century, Alexander Hamilton reported having used alternation to generate parallel comparison groups in a clinical trial of bloodletting done by him and two surgeon colleagues in 1816. He described how sick soldiers had been "*admitted,* alternately*, in such a manner that each of us had one third of the whole*" and that "*the sick were indiscriminately received*"," and "*attended as nearly as possible with the same care and accommodated with the same comforts*"[393]. Although his report leaves several uncertainties, it seems reasonable to speculate that he described the use of alternation to show that an effort had been made to generate comparable treatment groups.

By the middle of the 19th century, the rationale for alternation was sometimes being made explicit. In 1854, Thomas Graham Balfour described his assessment of whether belladonna could prevent scarlet fever. He divided 151 boys into two

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[391]Kaptchuk, T.J. (2011)
[392]Ibid
[393]Milne I, Chalmers I (2014). Alexander Le sassier Hamilton's 1816 report of a controlled trial of bloodletting. *JLL Bulletin: Commentaries on the history of treatment evaluation (https://www.jameslindlibrary.org/articles/alexander-lesassier-hamiltons-1816-report-of-a-controlled-trial-of-bloodletting/).*Accessed in June 2020.

comparison groups, "taking them alternately from the list, *to avoid the imputation of selection*"[394].

Alternate allocation became increasingly common during the first half of the 20th century. Indeed, alternation as a feature of research design became referred to formally in English not only simply as 'alternation', but also as 'the alternate method', 'rational alternation', and 'the alternate case method'. In French it was referred to as '*la méthode alternante*'; and in German as '*Simultanmethode*'. It is worth noting that designation of this methodological principle occurred before the theoretical statistical qualities of random allocation had been promoted in Ronald Fisher's *The Design of Experiments*[395]. Indeed, even though the word 'random' sometimes appeared in reports of controlled trials before the late 1940s, it was often actually alternation that was being used for allocation[396].

2.3. The gradual move from alternation to random allocation

Long before the concept of random allocation was introduced by statisticians, some doctors who wanted to compare preventive and therapeutic strategies recognized that comparison groups generated by alternate allocation would yield more credible evidence than comparison groups based on clinical decisions.

The principal disadvantage of alternate allocation is that it usually means that those making decisions about who will participate in treatment comparisons have

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[394] Chalmers I, Toth B (2009). 19th century controlled trials to test whether belladonna prevents scarlet fever. *JLL Bulletin: Commentaries on the history of treatment evaluation (https://www.jameslindlibrary.org/articles/19th-century-controlled-trials-to-test-whether-belladonna-prevents-scarlet-fever/)* accessed in June 2020

[395] Chalmers I, Dukan E, Podolsky SH, Davey Smith G (2011). The advent of fair treatment allocation schedules in clinical trials during the 19th and early 20th centuries. *JLL Bulletin: Commentaries on the history of treatment evaluation (https://www.jameslindlibrary.org/articles/the-advent-of-fair-treatment-allocation-schedules-in-clinical-trials-during-the-19th-and-early-20th-centuries/)* accessed in June 2020.

[396] Armitage P (2002). Randomisation and alternation: a note on Diehl et al. *JLL Bulletin: Commentaries on the history of treatment evaluation (https://www.jameslindlibrary.org/articles/randomisation-and-alternation-a-note-on-diehl-et-al/)* accessed in June 2020.

foreknowledge of upcoming allocations, and this sometimes leads them to undermine an allocation schedule that, in principle, should be unbiased[397].

In 1943-4, The Medical Research Council (MRC) UK carried out a trial to investigate patulin treatment for (an extract of Penicillium patulinum) the common cold. This was the first double blind comparative trial with concurrent controls in the general population in recent times. It was one of the last trial with non-randomized or quasi-randomized allocation of subjects. The study was rigorously controlled by keeping the physician and the patient blinded to the treatment. The treatment allocation was done using an alternation procedure. A nurse allocated the treatment in strict rotation in a separate room. The nurse filed the record counterfoil separately, and detached the code label for the appropriate bottle before asking the

patient to visit the doctor. The statisticians considered this an effective random concurrent allocation. .However, the outcome of the trial was disappointing as the analysis of trial data did not show any protective effect of patulin[398].

2.4. The MRC's Randomized Trial of Streptomycin

The idea of randomization was introduced in 1923. However, the first randomized control trial of streptomycin in pulmonary tuberculosis was carried out in 1946 by MRC of the UK.

The MRC Streptomycin in Tuberculosis Trials Committee (1946) was chaired by Sir Geoffrey Marshall, and the statistician was Sir Austin Bradford Hill whilst Philip Hart, who later directed the MRC's tuberculosis research unit, served as secretary. Marc Daniels, as the "registrar" coordinated the clinicians at the participating hospitals. The trial began in 1947[399].

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[397] Chalmers I, Dukan E, Podolsky SH, Davey Smith G (2011).
[398] Bhatt, (2010)
[399] Ibid

Streptomycin had been developed in the United States. The successful organization of the patulin trial appears to have been one of the reasons that the American producers of streptomycin invited the MRC to evaluate it[400]. As the amount of streptomycin available from the US was limited, it was ethically acceptable for the control subjects to be untreated by the drug—a statistician's dream.

A key advantage of Dr. Hill's randomization scheme over alternation procedure was “allocation concealment” at the time patients were enrolled in the trial. Another significant feature of the trial was the use of objective measures such as interpretation of x-rays by experts who were blinded to the patient's treatment assignment[401].

The MRC Streptomycin Committee was established in 1947 to oversee a ‘rigorously planned investigation with concurrent controls’, and the results of this study were published in the British Medical Journal in 1948.

“Determination of whether a patient would be treated by streptomycin and bed-rest (S case) or by bed-rest alone (C case) was made by reference to a statistical series based on random sampling numbers drawn up for each sex at each centre by Professor Bradford Hill; the details of the series were unknown to any of the investigators or to the co-coordinator and were contained in a set of sealed envelopes, each bearing on the outside only the name of the hospital and a number. After acceptance of a patient by the panel, and before admission to the streptomycin center, the appropriate numbered envelope was opened at the central office; the card inside told if the patient was to be an S or a C case, and this information was then given to the medical officer of the center. Patients were not told before admission that they were to get special treatment. C patients did not know throughout their stay in hospital that they were control patients in a special study; they were in fact treated as

[400] Chalmers I, Dukan E, Podolsky SH, Davey Smith G (2011)
[401] Bhatt, (2010)

they would have been in the past, the sole difference being that they had been admitted to the center more rapidly than was normal. Usually they were not in the same wards as S patients, but the same regime was maintained”[402].

Bradford Hill confirmed that the decision to use random allocation based on random number tables was as a precaution against allocation bias, hence his detailed references to ways of concealing allocation schedules from those involved in recruiting patients for clinical trials’[403].

The greatest influence of this trial lay in its methods which have affected virtually every area of clinical medicine. Over the years, as the discipline of controlled trials grew in sophistication and influence, the streptomycin trial continues to be referred to as ground breaking.

3. Evolution of Ethical and Regulatory Framework

Most advances in protection for human subjects have been a response to human abuses especially those taking place during World War II experiments.

The first International Guidance on the ethics of medical research involving subjects – the Nuremberg Code was formulated in 1947. Although informed consent for participation in research was described in 1900, the Nuremberg Code highlighted the essentiality of voluntariness of this consent. In 1948, the Universal Declaration of Human Rights (adopted by the General Assembly of the United Nations) expressed concern about rights of human beings being subjected to involuntary maltreatment. The brush with the thalidomide tragedy helped the U.S. pass the 1962 Kefauver-Harris

[402]Medical Research Council (1948). “Streptomycin treatment of pulmonary tuberculosis”. *BMJ* 2:769-782.
[403]Chalmers I (2005). “Statistical theory was not the reason that randomisation was used in the British Medical Research Council’s clinical trial of streptomycin for pulmonary tuberculosis”. In: Jorland G, Opinel A, Weisz G, eds. *Body counts: medical quantification in historical and sociological perspectives*. Montreal: McGill-Queens University Press, p 309-334.

amendments, which strengthened federal oversight of drug testing and included a requirement for informed consent[404].

In 1964 at Helsinki, the World Medical Association articulated general principles and specific guidelines on the use of human subjects in medical research, known as the Helsinki Declaration.

In 1966, the International Covenant on Civil and Political Rights specifically stated, 'No one shall be subjected to torture or to cruel, inhuman or degrading treatment or punishment. In particular, no one shall be subjected without his consent to medical or scientific treatment.' The US National Research Act of 1974 and Belmont Report of 1979 were major efforts in shaping the ethics of human experimentation. In 1996, the International Conference on Harmonization published Good Clinical Practice, which has become the universal standard for the ethical conduct of clinical trials[405].

[404] Bhatt, (2010)
[405] Jenkins, (1991)*Seminars in Oncology Nursing*, Vol 7, No 4 (November), 1991, pp 228-234

CONCLUSION

Contemporary medicine is the fruit of a continuity of intellectual efforts from several centuries and from several civilizations. The Islamic Civilization, rich with its ethnic diversity, drew on neighboring civilizations (Indian, Persian, and especially Greek) and contributed in a major way in the development of scientific thinking. The impact is palpable in several fields (philosophical, architectural, institutional and above all medical).

Western Civilization has experienced a translation movement leading to a transition of the centers of knowledge from Baghdad, Cairo, Fez, and Cordoba to Salerno, Paris and Oxford. It is safe to say that Western Civilization discovered the Greek science through Muslim scholars' writings. It has also inherited the basis of a scientific method based on experimentation thanks to geniuses such as Ibn Sina, Ibn al-Haytham, al-Zahrawi, Ibn-Rushd among many others. Islamic Civilization has therefore played a catalyst role in the evolution of human knowledge and directly contributed to the birth of Renaissance movement.

Indeed, the need for experiments in medical practice, the importance of animal studies before treating patients with a drug and acknowledgment of the differences between the physiologies of animals and humans, treatment comparisons to a control group, and introducing statistics to medical research can be traced back to the scientific insights of this golden period.

Empiricism was introduced into the Latin West in the second half of the twelfth century. Empiricist ideas and procedures were all available in Western Europe through the seminal works of Islamic scholars before the times of Galileo, Descartes and Newton to whom they have been largely attributed.

The consolidation of efforts from different civilizations has enriched the development of medical thought thanks to the uninterrupted accumulation of knowledge.

THE ROLE OF ISLAMIC CIVILIZATION IN THE EVOLUTION AND DEVELOPMENT OF MEDICAL THINKING: CLINICAL TRIALS

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Abstract

Clinical trial is seen as a foundation stone of contemporary medicine in the entire world. Its history is at least two millennia old. From personal diligence to international cooperation programs, the history of clinical trials covers a wide range of scientific, ethical, and regulatory challenges.

The evolution of clinical trials has gone through a long and fascinating journey. During the middle ages, physicians and philosophers of the Islamic civilization embraced and absorbed the Greek philosophy and the Persian medical knowledge and developed a scientific method based on both theory and experimentation. This Islamic logic influenced directly the Western civilization and directly contributed to the birth of Renaissance movement. This philosophical movement led to the basic approach of clinical trial in the 18th century. From that point, efforts were made to refine its design and statistical aspects. However, most of the contemporary sources on history of medicine propagate the idea that the roots of experimental medicine in its modern form, including clinical trials, first started during the European Renaissance in the 16th to the 18th centuries.

This thesis is an attempt to capture the major milestones in the evolution of clinical trials as an evolution of ideas. Shedding the lights on the Islamic civilization's contribution to the development of the scientific method and experimental medicine and following the landmark trials, models of meticulousness in design and implementation, which paved the way to the discipline of clinical trials to grow in sophistication and influence, leading to the flourishing of medical advancements of the present times.

Keywords: clinical trial, Islamic Civilization, medical thinking

LE ROLE DE LA CIVILISATION ISLAMIQUE DANS L'EVOLUTION ET LE DEVELOPPEMENT DE LA PENSÉE MÉDICALE: ESSAIS CLINIQUES

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Résumé

L'essai clinique est considéré, dans le monde entier, comme pierre angulaire de la médecine contemporaine. Son histoire remonte à au moins deux millénaires. De la diligence personnelle aux programmes de coopération internationale, l'histoire des essais cliniques couvre un large éventail de défis scientifiques, éthiques et réglementaires.

L'évolution des essais cliniques a connu un long et fascinant voyage. Au moyen-âge, les médecins et les philosophes de la civilisation islamique ont embrassé et absorbé la philosophie grecque et les connaissances médicales perses et ont développé une méthode scientifique basée à la fois sur la théorie et l'expérimentation. Cette logique islamique a influencé directement la civilisation occidentale et a directement contribué à la naissance du mouvement de la Renaissance. Ce mouvement philosophique a conduit à l'approche de base des essais cliniques au XVIIIe siècle. À partir de ce moment, des efforts ont été faits pour affiner sa conception et ses aspects statistiques. Cependant, la plupart des sources contemporaines sur l'histoire de la médecine propagent l'idée que les racines de la médecine expérimentale sous sa forme moderne, y compris les essais cliniques, ont commencé à la Renaissance européenne du XVIe au XVIIIe siècle.

Cette thèse tente de saisir les grandes étapes de l'évolution des essais cliniques en tant qu'évolution des idées. Elle met en valeur la contribution de la civilisation islamique au développement de la méthode scientifique et de la médecine expérimentale. Cette thèse suit les essais historiques phares, des modèles de méticulosité dans la conception et la mise en œuvre, qui ont permis à cette discipline de croître en sophistication et en influence, conduisant à l'épanouissement des progrès médicaux de l'époque actuelle.

Mots-clés: essai clinique, civilisation islamique, pensée médicale

دور الحضارة الإسلامية في تطور وتنمية التفكير الطبي: التجارب السريرية

رسام ياسين

تأطير : د. بنجلون البشير

ملخص

تعتبر التجربة السريرية حجر الأساس للطب المعاصر في العالم أجمع. تاريخها يمتد عما لا يقل عن ألفي سنة. انطلاقا من الاجتهادات الشخصية إلى برامج التعاون الدولي، يغطي تاريخ التجارب السريرية مجموعة واسعة من التحديات العلمية والأخلاقية والتنظيمية.

لقد عرف تطور التجارب السريرية رحلة طويلة ورائعة. خلال العصور الوسطى، تبنى واستوعب أطباء وفلاسفة الحضارة الإسلامية الفلسفة اليونانية والمعرفة الطبية الفارسية وطوروا طريقة علمية تستند إلى كل من النظرية والتجريب. أثر هذا المنطق الإسلامي بشكل مباشر على الحضارة الغربية وساهم بشكل مباشر في ولادة حركة النهضة. أدت هذه الحركة الفلسفية إلى النهج الأساسي للتجارب السريرية في القرن الثامن عشر. انطلاقا من هذه المرحلة، بذلت جهود لتحسين تصميم التجارب السريرية وجوانبها الإحصائية. ومع ذلك، فإن معظم المصادر المعاصرة في تاريخ الطب تدعم فكرة أن جذور الطب التجريبي في شكله أول مرة خلال عصر النهضة الأوروبية في القرنين السادس عشر والثامن عشر. الحديث، بما في ذلك التجارب السريرية، بدأت لتسليط هذه الأطروحة هي محاولة لالتقاط المعالم الرئيسية في تطور التجارب السريرية كتطور للأفكار. هي محاولة الأضواء على مساهمة الحضارة الإسلامية في تطوير المنهج العلمي والطب التجريبي. هذه الأطروحة تتبع التجارب البارزة تطورا وتأثيرا، مما أدى إلى ازدهار التطور ونماذج الدقة في التصميم والتنفيذ التي مهدت الطريق للتجارب السريرية لتزداد الطبي في العصر الحالي.

الكلمات المفتاحية: التجربة السريرية ، الحضارة الإسلامية ، التفكير الطبي

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Royaume du Maroc المملكة المغربية

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FACULTÉ DE MÉDECINE ET DE PHARMACIE

Université Sidi Mohamed Ben Abdellah

أطروحة رقم 20/157

سنـــة 2020

دور الحضارة الإسلامية في تطور وتنمية التفكير الطبي : التجارب السريرية

الأطروحة

قدمت و نوقشت علانية يوم 2020/11/05

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لنيل شهادة الدكتوراه في الطب

الكلمات الأساسية

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اللجنة

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