

ORIGINAL ARTICLE

The Fascinating Chronicle of Uroscopy: From the Era of Qarurah and Matula to the Microscope

Abstract

The objective of the present study is to elucidate the evolution of thoughts on urine inspection from antiquity to the present day. The classical Unani literature like Liber Regius, Canon of Medicine, Liber continens, Treasure of Khwarazmshah, etc. and the ancient literature of other traditional medicines like Ayurveda were prime sources of data. Additional sources were translations and summaries of the said classical books and scholarly articles written on the topic of urine. For recent advancements in uroscopy, browsing PubMed, Google Scholar, data science, and other trusted websites was carried out. Plentiful resources were frequently looked up and aided in the selection of topics for discussion in this review. With this intent, bibliographic research on the various classical literature was thoroughly sought out. In this regard, the classical literature of various traditional medicines was of immense help. Moreover, browsing trusted websites was carried out by searching for complementary and alternative medicine for uroscopy and urinalysis. Uroscopy has a long, colourful, and interesting history. The earliest evidence of urine inspection can be found in Babylonian, Sumerian, and Ayurvedic writings. Correspondingly, uroscopy has been practised for over 6,000 years. However, with the invention of the microscope, urinalysis became a valuable diagnostic tool in clinical practices. So essentially, urine represents a mirror image of the body's states, such as health and disease. Besides, Urinalysis has been evolving from antiquity to the present day, from time to time.

Key words: Unani Medicine, Urine, Bawl, Uroscopy, Urinalysis, Matula, Qarurah

Received: 8 Aug 2022; Accepted: 16 Nov 2022; Online published: 1 Feb 2023

Research on History of Medicine/ 2023 Feb; 12(1): 51-62.

Sidra (P.G. Scholar)¹
Sana Kauser Ateeque Ahmed (M.D.)²
Tasfiya Hakeem Ansari (M.D.)³
Abid Ali Ansari (M.D.)⁴
Azizur Rahman (M.D.)³
Aumir Rasool (P.G. Scholar)¹
Sheema (P.G. Scholar)⁵

1- Department of Mahiyatul Amraz (Pathology), National Institute of Unani Medicine, Bengaluru, India

2- Assistant Professor, Department of Mahiyatul Amraz (Pathology), Al-Ameen Unani Medical College, Malegaon, Maharashtra, India

3- Associate Professor, Department of Mahiyatul Amraz (Pathology), National Institute of Unani Medicine, Bengaluru, India

4- HoD & Professor, Department of Mahiyatul Amraz (Pathology), National Institute of Unani Medicine, Bengaluru, India

5- Department of Amraze Jild wa Tazeeniyat (Skin & Cosmetology), National Institute of Unani Medicine, Bengaluru, India

Correspondence:

Sana Kauser Ateeque Ahmed
Assistant Professor, Department of Mahiyatul Amraz (Pathology), Al-Ameen Unani Medical College, Malegaon, Maharashtra, India
sanakauserateequ@gmail.com

Citation:

Sidra, Ateeque Ahmed S.K., Ansari T.H., Ansari A.A., Rahman A., Rasool A., Sheema. The Fascinating Chronicle of Uroscopy: From the Era of Qarurah and Matula to the Microscope. *Res Hist Med.* 2023; 12(1): 51-62.



Introduction

The macroscopic/physical examination of the vital bodily fluid i.e., urine, also known as uroscopy, is as old as medicine itself. Urine provides a non-invasive technique of analysis (Shamsi, Haghverdi and Ashtiyani, 2014, p. 278). Uroscopy encompassed observations on colour, consistency, quantity, transparency, odour and the presence or absence of froth (Majoosi, 2010, pp. 53-55). It is believed that uroscopy is the earliest laboratory method utilised for diagnostic purposes. Although the instruments used in urine analysis have evolved from time to time, the necessity of observation and study of the urine has not. For instance, urine represents a mirror image of the body's states, such as health and disease. It aids in the diagnosis of a variety of bodily medical diseases. Thus, urine has undoubtedly been a topic of debate since antiquity. Delineation of analysis of urine can be found in ancient Sumerian and Babylonian literature of 6,000 years ago (Antic and DeMay, 2014, p. 103). Physical examination of urine was in practice for the diagnosis of diseases in Ancient Indian Medicine as well. The concept of Ayurveda back to 1500 BC. However, a description of the examination of urine can be found in the books of Charaka and Sushruta. They recognized and observed the sweet taste of diabetic urine by noticing the attraction of black ants towards sweet urine (Wellcome, 1911, p. 16). Moreover, some facts related to urine examination have been cited in Ancient Egyptian literature; including the papyrus of Kahun (1900 BC) too (Wright, et al., 2008, pp. 245-251). Unani physicians were well aware of the significance of urine in the diagnosis of diseases on top. Many renowned Unani scholars including Buqrat (Hippocrates- Father of medicine 460–377 BC), (Hippocrates, 1886, pp. 3-9) Jalinoo (Galen 131-201 BC), (History of Biomedical Science, 2005, p. 9) Ibne Sina (Avicenna 980–1037 AD) wrote a lot of important intimations regarding urine analysis (Antic and DeMay, 2014, p. 104). Furthermore, they emphasized the importance of a urine test in the diagnosis and prognosis of the disease (Shamsi, Haghverdi and Ashtiyani, 2014, pp. 278-285). According to the Unani System of Medicine (USM), there are four phases of digestion namely *Hadm Medi wa Mewi* (digestive processes of nutriment occurring inside the stomach and intestine), *Hadm Kabdi* (digestive processes/metabolism of nutriment occurring inside the liver), *Hadm Urooqi* (modification of nutriment occurring inside the vessels) and *Hadm Uzwi* (furthermore changes occurring inside the organ itself). Most of the Unani scholars believed that urine is the waste product of not only *Hadm Kabidi* but *Hadm Urooqi* as well (Kabiruddin, 1954, pp. 116, 330). However, according to Ibne Rushd (Averroes 1126-1198 AD), urine is the waste product of *Hadm Urooqi* only (Rushd, 2017, pp. 173-174). Thus, any abnormality in these phases of digestion might lead to changes in the urine, signifying the different ailments within the body.

Materials and Methods

A scrupulous literature search was conducted to grasp the chronology of urine analysis in different eras. Accordingly, the ancient Unani literature, classical Greco-Arabic medicine texts, research in Ayurveda and conventional medicine were searched. Further, browsing PubMed/Google Scholar, Scopus, Science Direct and other websites was carried out by searching keywords like urine, *Qarurah*, *Matula*, uroscopy, and comple-



mentary and alternative treatment for urine analysis. Moreover, research papers covering the data regarding the history of urine analysis were reviewed in detail.

Ancient Egypt (ca. 4300-2130 BC)

The old symbol for urine was a combination of water and phallus (Timeline of Ancient Egypt, n.d.; Wellcome, 1911, pp. 12-13). On clay tablets, Sumerian and Babylonian physicians documented their evaluations at about 4000 B.C. One of the first civilizations, Sumer, knew that different diseases could change the colour and consistency of urine (Wellcome, 1911, p. 12). Extended references to urine examination can also be found in ancient Egyptian texts; in the papyrus of Kahun (1900 BC) (Koss, and Hoda, 2012, pp. 1-5). In ancient Egypt about 1000 BC, as described in the literature, Egyptian priests were performing the most primitive procedure to confirm pregnancy and to identify the sex of a foetus as well. For the test, priests poured urine over mixed cereal seeds, if germination occurred then the test was considered positive. Yet, only by noting the actual type of seed that germinated it was possible to predict the sex of the foetus (Bolodeoku and Donaldson, 1996, pp. 623-626).

Classical Greece (480-323 BC)

Centuries back in the fourth century BC Hippocrates proposed that urine was a filtrate of four body humours that was sieved through the kidneys (Ducksters, 2022). Also, the doctrine of four humours was given by Hippocrates for the first time. According to this theory, Blood (*Dam*), Phlegm (*Balgham*), Yellow bile (*Safra*), and Black bile (*Sauda*) are four humours, each of them was supposed to come from a distinct part of the body; thereby embodying the pathology of a corresponding part of the body (Kabiruddin, 2009, pp. 59-60; Masihi, 2008, pp. 101-102). Therefore, it was a physician's job to keep the four humours in balance; as any disturbance could result in disease (Majoosi, 2010, pp. 60-66). Furthermore, Hippocrates stated the description of the several kinds of urine in disease by discussing the characteristics of urine in healthy persons as well (Diamandopoulos, 1997, pp. 222-227; Armstrong, 2007, pp. 384-387). Galen, the successor of Hippocrates, advanced his ideas. According to Galen, the kidneys enticed humours and also helped in removing superfluous or ruthless humours. Thus, urine was a diagnostic mirror of humoral imbalances (History of Biomedical Science, 2005, pp. 8-10). Marvellously it was the most widely accepted explanation of disease aetiology until the 16th century. Most of the contemporary tools for urine analysis are based on an almost similar concept. So, there is no place for non-scientific, foolish or ignorant modalities, in this approach.

Islamic Era (750-1258 AD)

Eminent Unani (Greco-Persian) scholars, like Abu Baker Muhammad Ibne Zakariya Razi (Namiranian, 2020, pp. 55-56) (Rhazes 865-925 AD) and Abu Al-Husayn Ibn Abdullah Ibne Sina (Avicenna 980-1037 AD), together with Ismail Jurjani (1040-1136AD), established uroscopy with scientific methods analogous to what is customary in the 21st century, barring the visualization of the different cells, crystals and microorganism as they did not have access to microscopes (Falagas, Zarkadoulia, and Samonis,



2006, pp. 1581-1586). Besides all these circumstances they were looking at urine not only to detect and diagnose renal disorders but also to judge the function of other organs and their relationship to urine quality.

Further, elaborate descriptions of the appearance of urine in various diseases are mentioned in renowned books of Unani scholars. So, their contribution to urology is far more imperative than what looks apparent. Here are some viewpoints on urology given by Rhazi in his renowned book *Al Hawi fit Tibb*:

- He expounds that “A normal Urine of a person indicates that he/she has competent vessels and circulation, however unripen urine” (less mature and not concentrated) is suggestive of weakness in vessels (Razi, 2007, pp. 7-150; Broumand, 2011, pp. 15-30).

- To distinguish between the vesicle and renal haematuria he explains that “*Sudden hematuria is due to a ruptured renal vessel and not because of the bladder*”. (Leonard, and Murphy, 1972, pp. 62-70).

- Another important feature given by him is, witnessing blood before urine during urination indicates the presence of an ulcer in the urethra (Broumand, 2011, pp. 15-30).

All these findings and diagnoses were essentially based on physical examination of the urine, and for that, they had to rely on their senses and experiences. They used the term ‘*Qarurah*’ (a pot/vessel for the collection of urine) in their writings however in the later period *Qarurah* term was used for the sample of urine (Shamsi, Haghverdi and Ashtiyani, 2014, pp. 278-281). *Qarurah* is an Arabic word that means flask (Dincer, 2001, p. 707). In a sample of urine, the Unani scholars witnessed these features i.e. 1. *Alwān al-Bawl* (Colour) 2. *Qiwām* (Consistency) 3. *Safayi Wa Kadurat* (Clarity and Turbidity) 4. *Miqdār* (Quantity) 5. *Rasūb* (Sediment) 6. *Kaf/Jhāg* (Foam) 7. *Bū* (Odour) (Avicenna, 1993, pp. 42-45). One more feature i.e. Mazah (Taste) was added by Razi (Broumand, 2011, pp. 15-30). According to the USM, there are four phases/types of digestion and urine was produced during the third digestion (Ashtiyani, et al., 2011, pp. 300-308). Ibne Sina mentioned in Canon of medicine, a famous encyclopaedia that “as urine spectators the quantity of consumed food and drink, therefore it is a sign of good and bad digestion,” and also “urine is an authentic shepherd for the data of the ailments”(Blagg, and Harrington, 2007, pp. 865-872; Avicenna, 1993, pp. 42-45). In the middle ages, it was assumed by the then scholars that almost every disease may perhaps be identified by urine examination (Armstrong, 2007, pp. 384-387). Moreover, there are several guidelines for the collection and examination of urine given by Unani scholars. Ismael Jurjani, the well-known Persian scholar, and the author of the great encyclopaedia *Zakhireh Kharazmshahi*, mentioned in the same that the urine must be collected in a large, transparent, and clean bottle, potentially in the shape of a bladder i.e. a round-bottomed flask, known as a *Qarurah* (Jurjani, 2010, pp. 53-80). However, it is believed that Matula is first mentioned by Hippocrates (Bynum and Bynum, 2016, p. 638). To guarantee that the urine remains in its normal form, the receptacle should have a shape that is comparable to that of the bladder. For this purpose, urine should be stored in a *qarurah* (phial) or urine collection containers at all times (Shamsi, Haghverdi and Ashtiyani, 2014, p. 282). Also, *Qarurah* should not be shaken excessively after getting filled up with urine. Furthermore, *Qarurah* should be examined in a proper light but without direct contact with sunlight (Avicenna, 1993, pp. 42-45). So essentially urine was seen as a sensible,



painless technique for the patients and physicians to detect and measure humoral imbalances viz. Sanguineous, Choleric, Phlegmatic and Melancholic (Ashtiyani, et al., 2011, pp. 300-308). (Figure 1)



Figure 1. *Qarurah* (*Qarurah*, n.d.)

Byzantine era (330-1453 AD)

The use of urine as a diagnostic tool has grown in popularity. As a diagnostic tool, urine became unrivalled by that time. Congruently urine testing for diagnostic purposes was common, resulting in technological uniformity. The first known laboratory procedure was documented by Theophilus Protospatharius. He conducted a urine experiment by heating a urine sample. Ensuing this, he revealed that Proteinuria would manifest as cloudiness as a result of the heat-precipitating proteins. In addition, Byzantine uroscopists gave an advanced examination of the urine sediment by stratification. This led to the change of the *Matula*'s bulbous shape into a more complex vessel, corresponding to the shape of the body (Bynum and Bynum, 2016, p. 638). Likewise, De Corbeil created the *Matula*, a clear, thin glass bladder with a rounded bottom that could be held up in the light for a thorough inspection. It was also known as 'jorden', a glass jug used by physicians to examine urine for colour, consistency, and clarity (Armstrong, 2007, pp. 384-387). Different portions of the vessel symbolised different parts of the body according to De Corbeil. It was divided vertically into four levels, with the topmost level signifying head disease, the second level for the heart and lungs, the third level for the belly and the fourth level for the urogenital organs (Mattelaer, 1999, pp. 145-150). The translucent bulbous urine glass, known as the *Matula*, became an emblem of a physician's rank and reputation anon.

Renaissance-era (1450-1600 AD)

Thereupon uroscopy became popular and widespread, so much so that it was practised in the home (Armstrong, 2007, pp. 384-387). De Ketham self-diagnostic colour wheel allowed people to diagnose their conditions by themselves. As a result, some



patients have abandoned physicians in favour of this ‘at-home’ diagnostic gadget. The self-diagnostic colour wheel was comprised of *Matula* which was surrounded by a big, circular urine colour wheel filled with 21 different coloured urine (Wittern-Sterzel, 1999, p. 2000). For diagnosis, the colour and consistency of the urine sample were matched to *Matula*’s colour. Added to this description of the four-body temperament can be found in four little circles, one at each corner of the wheel (Simerville, Maxted and Pahira, 2005). The urine colour wheel was principally based on the Hippocratic humoral theory of diseases. Because of that, the colour of the urine is a reflection of an imbalance in the four humours of the body. Since urine colour indicates the body’s temperament, henceforth the four temperaments (choleric, melancholy, sanguineous and phlegmatic) can be easily identified by using a urine colour wheel (Liang, and Clarke, 2010, pp. 185-191). Later during the 16th century, the evaluation of urine was expanded in the circles of Paracelsus’ followers who tested it with alchemical (or chymical) methods too (Wittern-Sterzel, 1999, p. 2000).

17th Century

The misuse of urine was getting amplified by that time. Once the urine sample fell into the hands of non-practitioners or so-called leaches, Urosocopy became a nightmare. In society, those who utilised urine for non-medical purposes were referred to as leaches. All at once, the use of uroscopy was mocked in pamphlets like Thomas Bryant’s-the Pisse Prophet and John Collop’s-a Pisspot Prophet. As a result, the *Matula* became objects of mockery and physicians were seen insolently (Armstrong, 2007, pp. 384-387). Besides Uromancy was acknowledged at that time. Uromancy was the study of urine for divination (fortune-telling), and uromancers were those who practised it. Also, every uromancer had a method of explaining its outcomes and relating them to fate (White, 1991, pp. 245-251).

18th Century and 19th Century

In this century, the word “urinalysis” came into existence (Armstrong, 2007, pp. 384-387). With the invention of the compound microscope, there started the development of Urine Cytology which was further revolutionised. The first ostensible compound microscope was invented in the late 16th century by Hans and Zacharias Janssen-A Dutch father-son crew (1585–1632) (Cameron, 2015, pp. S1453-S1464). It has the utmost importance for the analysis of urine sediment. Subsequently, the concept of urinalysis had been established as a valuable diagnostic tool in clinical practices. The microscope was first used in clinical practice to identify RBCs, Pus cells and a variety of crystals in urine. Followed by the invention of the microscope urine cytology has evolved into a tool for detecting cancer cells in a variety of body fluids. In the long run, Microscopic examination of urine is frequently performed to detect bacteria and cytological abnormalities (Antic and DeMay, 2014, p. 105). Furthermore, descriptions of specific gravity as well as the identification of proteins and chemical components in the urine, including urea were the most important contributions to the science of urinalysis. Johann Jacob Bezelius determined the specific gravity of typical urine to be 1.025. For this purpose, a mercury-based floating urinometer in the shape of a thermometer was used to determine



the specific gravity of urine. Johann Florian Heller (1813-1871) invented the urinometer in 1849. These findings aided in the development of a new scientific method for urine analysis (Bolodeoku and Donaldson, 1996, pp. 623-626).

20th Century

In the early twentieth century, the Lovibond comparator was used to test urine pH leading to the invention of the colour comparison method for determining urine pH. Selmar Aschheim and Bernhard Zondek invented a test to identify hCG in the urine of pregnant women for the first time. The dipstick tests, Clinistix (1956) for glucose and Albus-tix (1957) for proteinuria were developed respectively. Further, Clinitek, an automated reading instrument was established to read these strips (History of Biomedical Science, 2005, pp. 27, 36, 39). Since then, it has been commercially available. It is a fact that “Test strips” are a popular urinalysis technique nowadays. Eventually, microscopy, staining, and the study of cell morphology all made significant technological improvements at the turn of the twentieth century (History of Biomedical Science, 2005, pp. 28-32).

Present Time

The term nephrology and urology has evolved after thousands of years of rising and falling. Nephrology is a speciality within the internal medicine field related to kidney care (Brennan, 2021). Added to this nephrologists are experts in renal health, they study renal physiology and kidney diseases by observing urine. Urology is the field of medicine that focuses on diseases of the urinary tract and the male reproductive tract. Whereas Urologists diagnose and treat diseases of the urinary tract in both men and women (Timothy, 2018). Nowadays examination of urine encompassing physical appearance (colour, clarity, odour, volume, specific gravity, and/or osmolality); chemical examination (protein, blood glucose, pH, bilirubin, urobilinogen, ketone bodies, nitrites, and leukocyte esterase) and microscopic examination (crystals, red blood cells, white blood cells, epithelial cells, casts and microorganisms) are all standard tests. Also, Contrast phase microscopy is a modern technology for analyzing urine sediment that allows the identification of aberrant erythrocytes. Improvements in prior methods, fluorescence dyes, and more sophisticated dying protocols, such as the Cell Detect kit, have all aided classic morphology and cytology approaches (Magiorkinis, and Diamantis, 2015, pp. 1029-10036). Moreover, molecular biology advances in terms of PCR, real-time PCR, and next-generation sequencing can be used to diagnose malignant and nonmalignant illnesses in urine samples (Sugiyama, et al., 1995, pp. 142–147). (Figure 2)

Discussion and Conclusion

Urine is a sample-obtained that continuously supplies crucial information about the states of the body to physicians. Urine testing was thought to be an expedient way of revealing not only fundamental alterations in the four humours' balance but also the site of disease inside the body. Thus, examination and analysis of urine have been in practice since antiquity. The said practice was utilised for prognostic purposes as well. However, these practices have gone through a lot of innovation. It has been evolving as a uroscopy, microscopy and currently as molecular testing. Uroscopy; comprising of observations



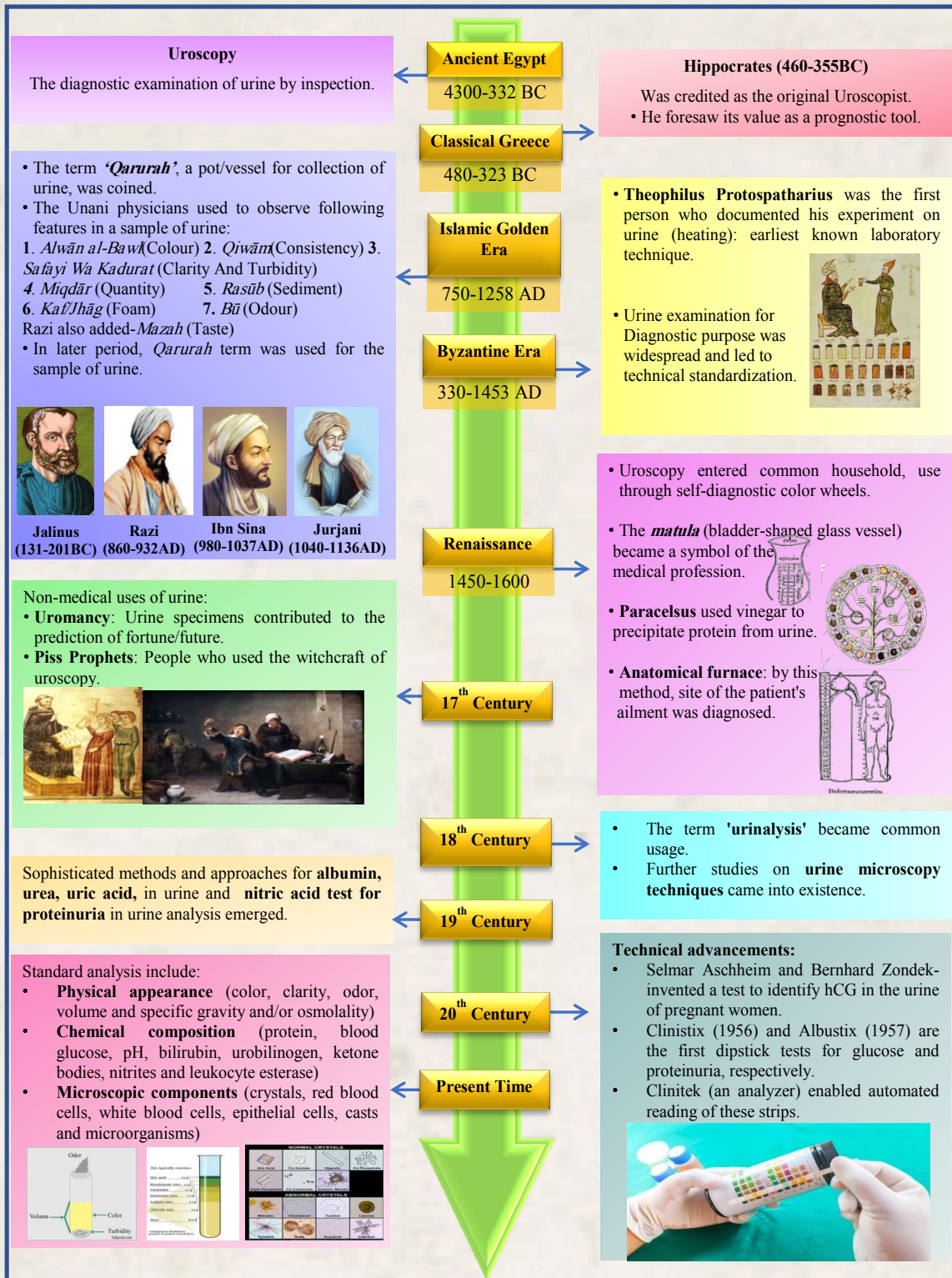


Figure 2. Chronicle of uroscopy from ancient age to till date

on colour, consistency, amount, clarity, odour, and the presence or absence of froth was relentlessly a part of the diagnostic tool for years. Contrarywise due to advancements in urinalysis, it is still mentioned as a macroscopic observation but without reliable diagnostic value without microscopic or molecular methods. Astutely urine analysis remained the mainstay of medical work in the public eye until it was finally surpassed by modern urinary chemistry in the nineteenth century. Added to this uroscopy, in particular, is no longer used in medical practices, but more advanced urine examination is still a useful diagnostic technique. However, the ancient approach in laboratory medicine has been applicable so far in the present day. Further molecular testing of urine includes the reverse transcription-polymerase chain reaction (RT-PCR) which is performed on urine sediment. Of late it has been established as a molecular biological procedure that is now used to diagnose uroepithelial cancers too. Countless diseases can now be detected by urine clinical testing, thanks to these advanced techniques. So in a nutshell the combination of cytological diagnostics of urine with prospective emerging molecular approaches will be the state-of-the-art methodology in the future.

Acknowledgements

The author is highly indebted to Dr. Sana Kauser Ateeque Ahmed (Assistant Professor) for her contribution to this paper. She moulded this paper and gave it a shape. She is now the Corresponding author.

Conflict of Interest

Authors have no conflicts of interest.

References

- Anatomical furnace. [Online]. Available at https://www.researchgate.net/figure/Figure-No-4-Anatomical-furnace-human-body-shaped_fig2_350286689 [Accessed 23 Feb 2022]
- Antic, T., and DeMay, R.M., 2014. The fascinating history of urine examination. *Journal of the American Society of Cytopathology*, 3(2), pp. 103–107. doi: 10.1016/j.jasc.2013.12.005.
- Armstrong, J.A., 2007. Urinalysis in western culture: A brief history. *Kidney International*, 71(5), pp. 384–387. doi: 10.1038/sj.ki.5002057.
- Ashtiyani, S.C., et al. 2011. A critical review of the works of pioneer physicians on Kidney Diseases in Ancient Iran: Avicenna, Rhazes, Al-Akhawayni, and Jorjani. *Iranian Journal of Kidney Diseases*, 5(5), pp. 300–308.
- Avicenna, H.I., 1993. *Canon of Medicine*. English Translation. General Principles of Medicine', Book 1, pp. 42–45. Available at: <http://naimh.com/canon/CANON-Book-I-Hamdard.pdf%0APaul> [Accessed 5 September 2022]
- Avicenna. [Online]. Available at <https://www.global-ehsan-relief.org/news/lifestyle/the-islamic-golden-age-the-prolific-ibn-sina/> [Accessed 23 Feb 2022]
- Brennan, D. 2021. What Is a Nephrologist?. A to Z menu, Web MD Editorial Contributors. Available at: <https://www.webmd.com/a-to-z-guides/what-isnephrologist> [Accessed 6 September 2022]
- Blagg, C.R., and Harrington, J.T., 2007. Looking at the Urine: The Renaissance of an Unbroken.



- American Journal of Kidney Diseases*, 49(6), pp. 865–872. doi: 10.1053/j.ajkd.2007.04.003.
- Bolodeoku, J., and Donaldson, D., 1996. Urinalysis in clinical diagnosis. *Journal of Clinical Pathology*, 49(8), pp. 623–626. doi: 10.1136/jcp.49.8.623.
- Broumand, B., 2011. History of urinalysis by Razi and Avicenna in Iran and their clinical judgment from urinalysis. *CIN 2011: 6th Congress of Nephrology in Internet*, pp. 15–30.
- Bynum, B., and Bynum, H., 2016. The matula. *The Lancet*, 387(10019), p. 638. doi: 10.1016/S0140-6736(16)00289-0.
- Cameron, J.S., 2015. A history of urine microscopy. *Clinical Chemistry and Laboratory Medicine*, 53, pp. S1453–S1464. doi: 10.1515/cclm-2015-0479.
- Chemical. [Online]. Available at <https://slideplayer.com/slide/10116489/> [Accessed 23 Feb 2022]
- Mircoscopic. [Online]. Available at <https://microbiologyinfo.com/types-of-crystals-in-urine/> [Accessed 23 Feb 2022]
- Diamandopoulos, A.A., 1997. Uroscopy in Byzantium. *American Journal of Nephrology*, 17(3–4), pp. 222–227. doi: 10.1159/000169105.
- Dincer, M., 2001. International society for the history of Islamic medicine. *Lancet Oncology*, 2(11), p. 707. doi: 10.1016/S1470-2045(01)00563-0.
- De Katham colour chart. [Online]. Available at <https://www.sciencephoto.com/media/300104/view/medieval-urine-wheel> [Accessed 23 Feb 2022]
- Ducksters, 2022. History: Ancient Greece Timeline for Kids. Ducksters. Available at: https://www.ducksters.com/history/ancient_greek_timeline.php [Accessed 8 September 2022]
- Falagas, M.E., Zarkadoulia, E.A., and Samonis, G., 2006. Arab science in the golden age (750–1258 C.E.) and today. *The FASEB Journal*, 20(10), pp. 1581–1586. doi: 10.1096/fj.06-0803ufm.
- Hippocrates, A., F., 1886. *The genuine works of Hippocrates*. Translated from the Greek with a preliminary discourse and annotations. [e-book]. New York: W. Wood Collection. Available at: <https://archive.org/details/genuineworkship02hippgoog/page/n14/mode/2up> [Accessed 02 September 2022]
- History of Biomedical Science, 2005. In: ‘From Matula to Mass Spectrometry’ A history of urine tests in the investigation of human disease, A booklet to accompany an exhibition presented by the IBMS Historical Section Committee at the IBMS Biomedical Science Congress 26th – 28th September. London: U.K. Available at: <https://www.ibms.org/resources/documents/history-of-urine-testing/> [Accessed 02 September 2022]
- Jalinus. [Online]. Available at <https://www.sciencephoto.com/media/707365/view/galen-greek-physician-and-philosopher> [Accessed 23 Feb 2022].
- Jurjani, I., 2010. *Zakhira khwarizam Shahi*. New Delhi: Idara Kitabus Shifa.
- Jurjani. [Online]. Available at <https://biografi.kamikamu.co.id/al-jurjani-dokter-penyusun-ensiklopedia/> [Accessed 23 Feb 2022]
- Kabiruddin, H., 1954. *Kulliyat-e-Nafeesi*. New Delhi: Idara Kitabul Shifa.
- Kabiruddin, M., 2009. *Kitabul Akhlat*. New Delhi: CCRUM.
- Koss, L.G., Hoda, R.S., 2012. Introduction. In: Koss’s Cytology of the Urinary Tract with Histopathologic Correlations. Springer, Boston, MA. Available at: https://doi.org/10.1007/978-1-4614-2056-9_1 [Accessed 20 June 2022]
- Leonard, J.T., and Murphy, E.D., 1972. *The history of urology Part-1*. Springfield: Thomas books.



- Leopold, G.K., and Rana, S.H., 2012. *Koss's Cytology of the Urinary Tract with Histopathologic Correlations*. USA: Springer.
- Liang, S., and Clarke, W., 2010. *The Urinary Proteome*, in: A.J. Rai, (eds), *Methods in Molecular Biology*, Vol. 641(4). n.p.: Humana Press. doi: 10.1007/978-1-60761-711-2.
- Magiorkinis, E., and Diamantis, A., 2015. The fascinating story of urine examination: From uroscopy to the era of microscopy and beyond. *Diagnostic Cytopathology*, 43(12), p.1020-1036.
- Majoosi, A., 2010. *Kamilus Sana*. New Delhi: Idara Kitabus Shifa.
- Masihi A.S., 2008. *Kitab-ul-Mia*. Urdu Translation. Vol. 1. New Delhi: CCRUM, Department of AYUSH, Ministry of H & FW.
- Mattelaer, J.J., 1999. Some historical aspects of urinals and urine receptacles. *World Journal of Urology*, 17(3), pp. 145–150. doi: 10.1007/s003450050122.
- Matula. [Online]. Available at <https://wellcomecollection.org/works/egjhpyfe> [Accessed 23 Feb 2022]
- Namiranian, P., 2020. Book Review: Conventional Medicine and Rhazi's Viewpoints on Urology. *Asian Journal of Traditional, Complementary and Alternative Medicines*, 3(1-2), pp. 55–56. doi: 10.22040/ATCAM.2019.108143.
- Physical examination. [Online]. Available at <https://labpedia.net/urine-history-urine-composition-normal-findings-advantages-of-urine-analysis/> [Accessed 23 Feb 2022]
- Piss Prophets. [Online]. Available at <http://www.forbiddenhistories.com/2019/04/uromancy-lindsey-fitzharris/> [Accessed 23 Feb 2022]
- Qarurah*, n.d. [Online]. Available at <https://www.thelancet.com/pdfs/journals/lancet/PIIS0140-6736%2816%2900289-0.pdf> [Accessed 23 Feb 2022]
- Razi, A.B.M.I.Z., 2007. *Kitab al Hawi*. Urdu Translation by CCRUM. Vol. 19. New Delhi: CCRUM Ministry of H&FW.
- Razi. [Online]. Available at [https://en.wikipedia.org/wiki/File:Rhazes_\(al-Razi\)_\(AD_865_-_925\)_Wellcome_S0001954.jpg](https://en.wikipedia.org/wiki/File:Rhazes_(al-Razi)_(AD_865_-_925)_Wellcome_S0001954.jpg) [Accessed 23 Feb 2022]
- Rushd, A.W.I., 2017. *Kitab-ul-Kulliyat*. Lahore: Maktab AL Daniyal.
- Shamsi, M., Haghverdi, F., and Ashtiyani, S.C., 2014. A brief review of Rhazes, Avicenna, and Jorjani's views on diagnosis of diseases through urine examination. *Iranian Journal of Kidney Diseases*, 8(4), pp. 278–285.
- Simerville, J.A., Maxted, W.C., and Pahira, J.J., 2005. Urinalysis: A comprehensive review. *American Family Physician*, 71(6), pp. 1153–1162.
- Sugiyama, M., Woodman, A., Sugino, T., Crowley, S., Ho, K., Smith, J., et al. 1995. Non-invasive detection of bladder cancer by identification of abnormal CD44 proteins in exfoliated cancer cells in urine. *Clinical molecular pathology*, 48(3), pp. 142–147. doi: 10.1136/mp.48.3.m142
- Technical advancement. [Online]. Available at <https://www.stuff.co.nz/life-style/well-good/teach-me/91970353/what-can-your-doctor-tell-from-your-urine> [Accessed 23 Feb 2022]
- Timeline of Ancient Egypt. The University of Memphis, Tennessee (USA). Available at: <https://www.memphis.edu/egypt/resources/timeline.php> [Accessed 2 September 2022]
- Timothy, J.L., 2018. Faces of Healthcare: What Is a Urologist?. Healthline. Available at: <https://www.healthline.com/health/what-is-urologist#urologist> [Accessed 6 September 2022]
- Uromancy. [Online]. Available at <https://www.ancient-origins.net/history-ancient-traditions/>



urine-wheel-and-uroscopy-your-wee-could-tell-medieval-doctor-009744 [Accessed 23 Feb 2022]

Wellcome, H.S.W.B., 1911. *Uroscopy in antiquity*, in: *The evolution of urine analysis: An historical sketch of the clinical examination of urine*. London: Burroughs Wellcome.

White, W.I., 1991. A new look at the role of urinalysis in the history of diagnostic medicine. *Clinical Chemistry*, 37(1), pp. 119–125. doi: 10.1093/clinchem/37.1.119.

Wittern-Sterzel, R., 1999. Diagnosis: The doctor and the urine glass. *Lancet*, 354(9196 SUPPL.), p. 2000. doi: 10.1016/S0140-6736(99)90356-2.

Wright, C.A., et al., 2008. Diagnosing Mycobacterial Lymphadenitis in Children Using Fine Needle Aspiration Biopsy: Cytomorphology, ZN Staining and Autofluorescence — Making More of Less. *Diagnostic Cytopathology*, 36(4), pp. 245–251. doi: 10.1002/dc.

