

de Ketham revisited: a modern-day urine wheel

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During the Middle Ages, uroscopy was an important tool for evaluating health, and medical practitioners often carried Johannes de Ketham's urine wheel as a diagnostic aid. In honour of de Ketham, a modern urine wheel is presented, which may be a useful diagnostic tool for present-day physicians.

Hippocrates, Aristotle and the ancient Egyptians inferred diagnoses from urine evaluation, but it was not until the Middle Ages that uroscopy reached diagnostic dominance. A major reason for its rise to prominence was the publication of Johannes de Ketham's *Fasciculus medicinae* in 1491.¹ This was the first illustrated medical book printed and is also among the most beautiful of such texts. The importance it places on urine evaluation is evident on page 1b, which depicts a urine wheel: a large circle surrounded by 21 thin-necked, urine-filled flasks (*matulae*) (Box 1). This wheel shows how the colour and consistency of urine could be matched to a diagnosis. Disease was thought to result from the imbalance of humours, reflected by urine colour. In the corners of the urine wheel, four small circles contain descriptions of the four temperaments: sanguineous, choleric, phlegmatic and melancholic.

In an era nearly four centuries earlier than Laënnec's stethoscope, three centuries before the first investigations into blood

pressure and two centuries earlier than Hooke's microscope, uroscopy became the most important tool in evaluating internal health of the human body — more highly valued than the pulse. Its use is depicted by a woodcut from the first Italian edition of de Ketham's *Fasciculus medicinae*, showing a professor teaching diagnosis by uroscopy as different *matulae* are presented to him (Box 2). Although modern technology allows greater insight into the hidden clues of bodily functions, visual observation of urine is still useful. A contemporary urine wheel with diagnoses that might be associated with visually abnormal urine is presented in Box 3.

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Competing interests

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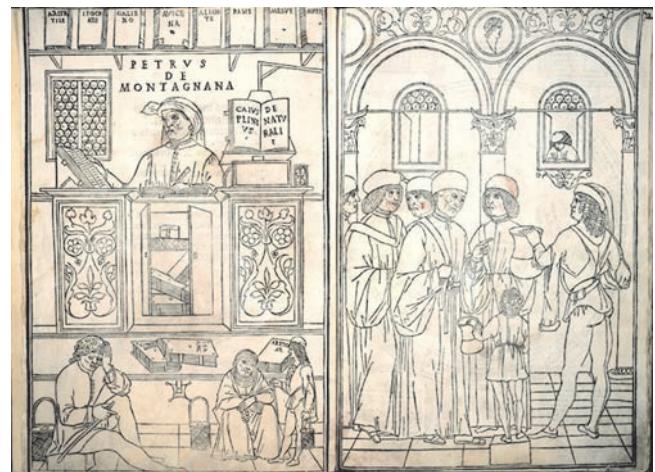
References*

- 1 de Ketham J. *Fasciculus Medicinae*. Venice: Johannem et Gregorium fratres de Forlivio, 1491.
- 2 Jungersen K. The relation between text and colours in medieval urine wheels. <http://www.mhm.ku.dk/upload/urinposter.pdf> (accessed Oct 2008).

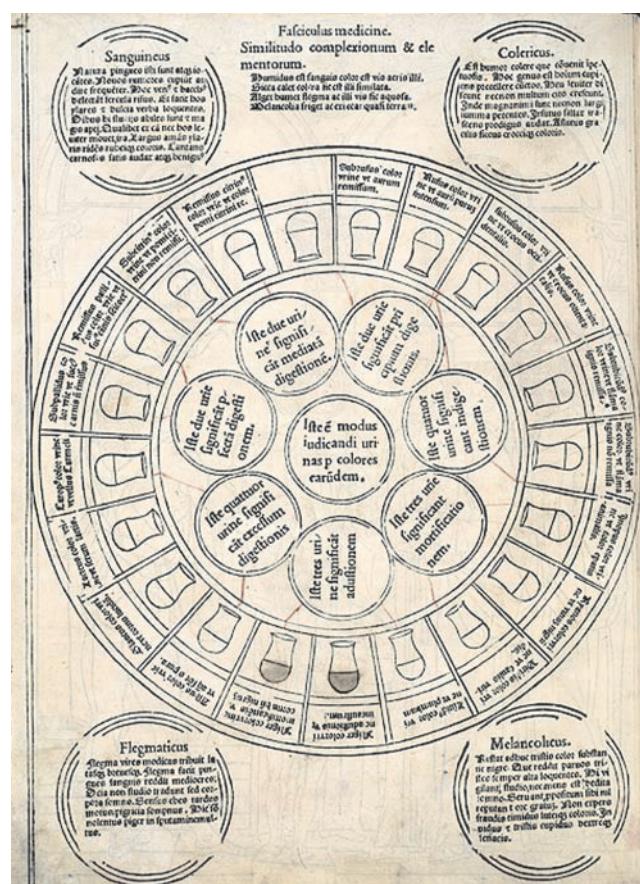
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*A complete list of references is available from the author.

2 Professor teaching diagnosis by uroscopy



1 Urine wheel from the first edition of *Fasciculus medicinae**



* An English translation of de Ketham's urine wheel is available at www.mhm.ku.dk/upload/urinposter.pdf.²

3 A modern-day urine wheel that contrasts de Ketham's diagnoses (italics) with modern interpretations of urine appearance



1–2. Yellow: a sanguine personality (yellow), while white (that we might call colourless) is mortal in acute fevers.

Bilirubin and urobilinogen are responsible for the yellow colour of urine and more concentrated urine may appear darker. Colour charts are useful in monitoring hydration in nursing home patients, but this is not reliable in athletes after exercise. Conjugated bilirubin, urobilinogen, carotenaemia, diabetes, hypothyroidism, anorexia nervosa and *Serratia marcescens* infection can also result in darker yellow urine.



3–4. Pink-red: a choleric personality, or “fever from excess blood” requiring bloodletting.

Pink-red often indicates haematuria; bladder infections are a common cause but urological injury, cancer and strenuous exercise can also cause haematuria. In addition, haemoglobinuria (eg, paroxysmal nocturnal haemoglobinuria) can be visually indistinct from haematuria. Similarly, porphyria, myoglobinuria, the sedative propofol, phenytoin, rhodamine B, ibuprofen, methyldopa, chloroquine, azosulfamide, nitrofurantoin, rifampicin, *Serratia marcescens*, food dye, red clover, beetroot pigment, blackberries, rhubarb, phenolphthalein and high concentrations of uric acid (which has been described as apricot-coloured) produced after gastric bypass can cause pink-red urine. Use of beefsteak juice to simulate myoglobinuria in Munchausen syndrome is particularly innovative.



5–6. Orange: death or a hectic fever in dropsical [oedematous] patients.

Orange can indicate high levels of urobilinogen and conjugated bilirubin. Beetroot pigment, rifampin, phenothiazines, phenazopyridine, iron and porphyria have also been associated with orange urine.



7. Black: mortification due to extinguished natural heat.

Alkaptonuria (a genetic disorder of tyrosine metabolism), rhabdomyolysis, povidone-iodine ingestion of cascara (a bark), levodopa, metoclopramide, senna, and melanin formation (from α -methyldopa precipitate in alkaline urine) have been reported to cause black urine.



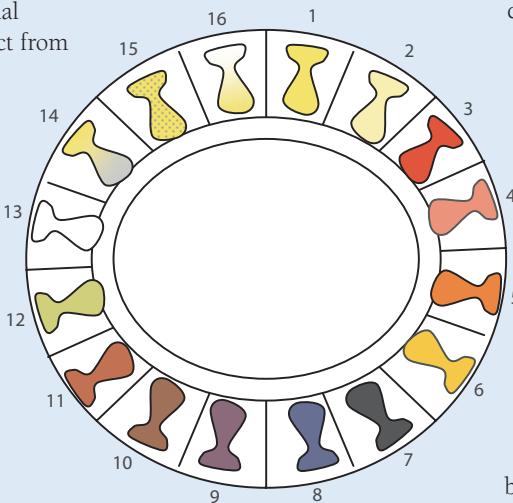
8. Blue: a melancholic personality.

Chronic constipation results in bacterial overgrowth in the bowel, where tryptophan is converted to indole; in the liver, indole is metabolised to indoxyl sulfate, which is degraded by bacteria to produce an indigo colour. Many believe King George III's medical problems were due to porphyria but some hypothesise that he had indigo urine due to chronic constipation. Blue diaper syndrome has been reported in familial indicanuria, while jering (a Malaysian delicacy), amitriptyline, intravenous cimetidine, intravenous promethazine, methylene blue and triamterene have also been reported to produce blue urine. Methylene blue is used diagnostically and to treat methaemoglobinemia, but is also contained in many over-the-counter preparations for unexpected therapies such as eye and urinary tract infections.



9. Purple: not mentioned by de Ketham.

Formation of purple urine is similar to that of blue urine, with addition of indirubin — a red pigment derived from bacterial metabolism of indoxyl sulfate.



10–11. Brown: a multitude of corrupted humours.

Niridazole, phenacetin, levodopa, hydroxychloroquine and porphyria can cause brown urine.



12. Green: a choleric personality.

Green urine has been associated with biliverdin, *Pseudomonas* infection, food dye, meconium aspiration, pernicious anaemia with indicanuria, topical resorcinol, methylene blue, indigo blue dyes, mitozantrone, tetrahydronaphthalene, cloquinol, chlorophyll-containing gum, methocarbamol, cimetidine, zaleplon, promethazine, amitriptyline, indomethacin, triamterene, metoclopramide and propofol.



13–14. White or “milk-like”: dropsy [oedema].

Massive proteinuria resulting in oedema can cause milky urine, as can chyluria and propofol.



16. Foamy or “white”: a windiness boiling up in the urine channels.

Foamy urine usually results from decreased surface tension as protein molecules orient themselves to the surface — a marker for proteinuria and incipient renal disease (as predicted by Hippocrates).



15. Turbid: the woman is not a virgin.

Turbidity can indicate a urinary tract infection or crystalluria; urine clarity is useful for ruling out infection, even to those without medical training.