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Received: 1 February 2024 | Accepted: 19 May 2024

DOI: 10.1111/1467-9566.13803

ORIGINAL ARTICLE

SOCIOLOGY OF HEALTH & ILLNESS

'When all you have is a hammer, everything has to be a nail': Managing diagnostic uncertainty in urinary tract infection

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Funding information
Wellcome Trust, Grant/Award Number: 214954 PI Catherine Will; Foundation for the Sociology of Health and Illness, Grant/Award Number: Mildred Blaxter Postdoctoral Award

Abstract

Diagnosis of urinary tract infections (UTI) is a routine part of medical work and yet is well recognised to be an area of high clinical uncertainty. Meanwhile, diagnosis of UTI is becoming increasingly important to policy-makers globally due to concerns about antibiotic over-prescription. Drawing on Mol's concept of ontological multiplicity in clinical work, I explore how diagnostic uncertainty is co-ordinated into certainty by a UK national diagnostic algorithm for UTI. The diagnosis of UTI is produced or withheld as a *post hoc* rationalisation of a prior decision whether to prescribe antibiotics or not. Work in the sociology of diagnosis has already noted that diagnostic steps are often re-ordered by health-care professionals taking diverse actions in the best interest of their patients. This article contributes an argument that ordering diagnostic work around antimicrobial stewardship agendas has the effect of narrowing possible actions. Exploring the consequences and effects of doing diagnosis in this way for different groups, I argue that a greater creativity about what could be done to care for painful bladders could be found in a return to more clinical ways of working.

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KEYWORDS
AMR, antimicrobial resistance, diagnosis, primary care, urinary tract infection, UTI

INTRODUCTION: UTI & AMR

Cystitis refers to inflammation of the urinary bladder and can be caused by a bacterial urinary tract infection (UTI). Diagnosis of UTI has long been problematic from a clinical perspective because not all experiences of cystitis have a bacterial cause (Smith et al., 2018; p. ii15; Bent et al., 2002) and the gold-standard diagnostic technology, the mid-stream urine (MSU) culture, is performed at a temporal and spatial distance from the patient.

More recently, diagnosis of UTI has become a key focus of policymaking around antimicrobial resistance (AMR). The association between antibiotic use and emergent resistance is well-established (Costelloe et al., 2010) while UTI accounts for a high proportion of antibiotic prescribing (Dolk et al., 2018, p. ii6). Researchers from the United Kingdom Health Security Agency's (UKHSA) National Infection Service identified 25% of antibiotic prescriptions linked to a diagnosis of acute UTI in non-pregnant women in England as inappropriate (Smith et al., 2018). Diagnosis of UTI therefore appears as an important issue for policymakers aiming to more effectively target antibiotics.

The prescription of antibiotics for UTI in primary care is often described as 'empirical' (NICE, 2018, p. 25; NICE, 2022), a bio-medical term meaning that a treatment decision has been made amidst diagnostic uncertainty, based on observation, experience and expertise. Therefore, although diagnosis of UTI is a routine part of medical work in general practice, it is recognised as an area of high uncertainty. Policy interventions are designed to intervene in complex and uncertain processes of diagnosis.

Uncertainty surrounds not only accurate identification of an infective aetiology but also the relationship between a diagnosis of UTI and the threshold to treat (Hoffmann et al., 2020). Increased prescribing for UTI has driven resistance in urinary isolates, making UTIs harder to treat but also potentially driving life-threatening bloodstream infections (Lishman et al., 2018; Pouwels et al., 2019). At the same time, antibiotic treatment is understood to be required in a higher proportion of cases for UTI than for other comparable diagnoses, such as respiratory tract infections (Hoffmann et al., 2020; Pouwels et al., 2018; Smith et al., 2018). Judicious and effective treatment of UTI in the community, balancing tensions between under-treating and over-treating amidst high levels of uncertainty (Kashouris et al., 2023), may be important in reducing rates of uro-sepsis (Cooper et al., 2020). Targeting antibiotics at those who stand to benefit more than they stand to be harmed is therefore a complex process when it comes to UTI.

In England, Wales, and Northern Ireland, diagnosis of UTI in women under 65 is co-ordinated (Timmermans & Berg, 2003, p. 98) via a diagnostic algorithm developed by UKHSA and endorsed by the National Institute for Health and Care Excellence (NICE), the Royal College of General Practitioners and the Royal Pharmaceutical Society (UKHSA, 2020, p. 2) (Figure 1). The algorithm is part of a suite of UTI resources within TARGET, the national antimicrobial stewardship (AMS) programme for primary care (2021), and takes the form of a manual flow-chart. TARGET stands for 'Treat Antibiotics Responsibly, Guidance, Education and Tools.' As Roope et al. note, citing TARGET, 'reductions in antibiotic use have been

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achieved in primary care by raising the threshold for starting patients on antibiotics' (2020, p. 2). This approach is in line with global responses to AMR as a problem of excess, centring overall reduction in antibiotics (Chandler, 2019, p. 4). The diagnostic algorithm is a technology which is intended to drive down antibiotic use for UTI amidst diagnostic uncertainty and uncertainty about the threshold to treat.[1]

In this article, I use insights from medical sociology and Science and Technology Studies (STS) to explore the ontology of diagnosis of UTI in this diagnostic algorithm.[2] By diagnostic ontology, I refer to questions of how medicine places a label upon a phenomenon and the implications of this (Jutel, 2011, p. 16). The problem of diagnostic uncertainty that asks 'does this patient have a UTI?' is not co-ordinated into practice by this algorithm. Mol's work on ontological multiplicity (2002) argues that such questions of representative knowledge are rare in clinical medicine but that different versions of the same disease can co-exist when they are co-ordinated towards the question of what to do. Drawing on this concept, I contribute a different case by arguing that the algorithm intervenes in diagnostic uncertainty by centring the question of whether to prescribe antibiotics or not. A diagnosis of UTI is produced as a *post hoc* justification of this decision. By asking why ontological and epistemological questions about diagnosis have been raised and addressed in this way (Weinberg, p. 385, 2021), my argument explores what is at stake for different overlapping groups such as policymakers, clinicians and patients involved in the issue of UTI diagnosis. I show that the diagnostic algorithm functions well as a technology of AMS for the patient groups it was designed for. However, this way of doing diagnosis, which pulls UTI out of other diagnoses because of its relation to antibiotics, has poor consequences for the care of symptomatic patient groups once they have been identified as un-likely to benefit from antibiotics. A process of diagnosis which is so closely orientated around antibiotics forecloses other ways of caring for painful bladders. This means that AMS interventions designed to reduce antibiotic use have a perverse potential to sustain antibiotic use, leading to poor care for groups unlikely to benefit from antibiotic treatment.

ONTOLOGIES OF DIAGNOSIS-WHAT IS AT STAKE?

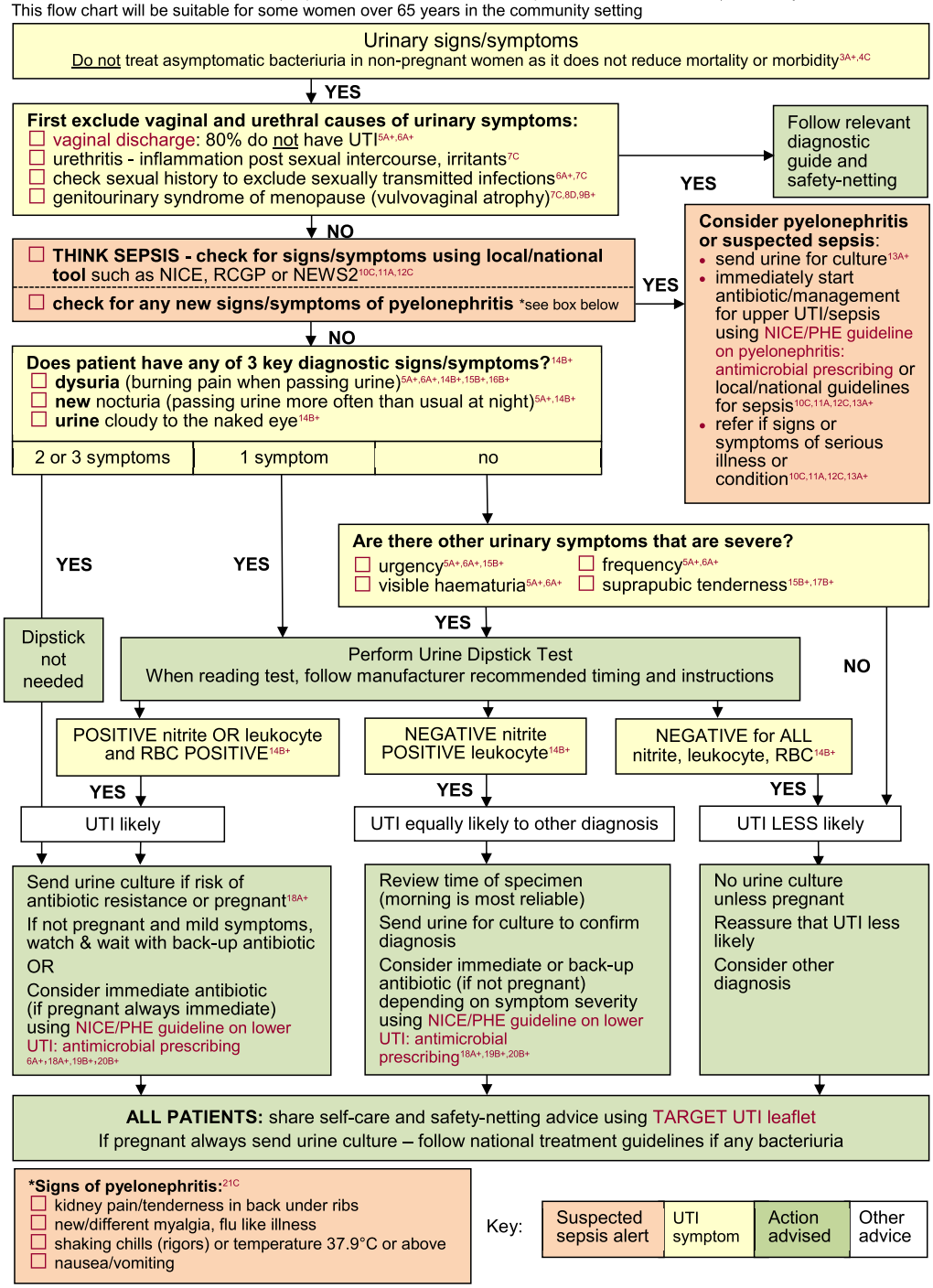
The UKHSA/NICE diagnostic algorithm pictorialises a process of diagnosis which starts at symptoms (step 1), travelling down through diagnostic technologies (step 2), through the production of a disease category (UTI) (step 3) and ends at decisions about therapeutic outcomes (step 4). The arrows flow chronologically from one step to another. The way the algorithm is presented implies a stepwise progression in the diagnostic process. In other words, the question pictorialised and narrativised by the diagnostic algorithm is 'what is wrong' followed by 'what to do about it.' Scholars across medical sociology and STS have highlighted an attentiveness to the way that steps may be re-ordered, omitted or elided according to what health-care professionals (HCPs) perceive to be in the best interest of their patient, even as there is often a presentation of this stepwise sequence.

Rasmussen et al. (2023) show that HCPs often anticipate what is to be done in the best interest of their individual patient and then produce a diagnostic label in order to justify this. Calling this 'diagnosis by anticipation', they argue that it is when HCPs experience ambiguity or uncertainty about disease identification, that they are more likely to provide a diagnosis based on anticipated outcomes. Relevant effects of different diagnoses include the success of insurance claims, participation in patients' identity work, mitigation of potentially stigmatising diagnoses, *etc*. (2023, p. 8). In the cases considered here, the diagnostic label itself can be

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Diagnosis of urinary tract infections: quick reference tool for primary care.

Flowchart for women (under 65 years) with suspected UTI



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therapeutic or have therapeutic consequences, blurring the ontological difference between step 3 (disease categories) and step 4 (therapeutic outcomes). However, that a diagnostic category is produced at all tells us that it is important here to *present* a stepwise progression from step 1 to step 4, even as Rasmussen et al. argue that amidst uncertainty, diagnosis is often disordered, or rather, ordered, more as an ethically orientated practice than one which is concerned with accurate identification of disease. The identification of condition X takes place after the question of 'what to do' is resolved, but importantly, condition X is produced in order to resolve uncertainty and justify what is to be done.

This is an example of how a disease category may be produced, even if 'what is wrong' is not the question around which practices of diagnosis are orientated. The issue of why the production of a disease category is important to medical work has been extensively explored in medical sociology. In particular, literature around professionalisation has pointed out that the conceptual model of diagnosis as producing a disease category from a nosology of organic pathology is productive in accrediting diagnosticians with specialist expertise (Hobson-West & Jutel, 2020; Rosenberg, 2002) and autonomy (Whooley, 2010).

Meanwhile, work in STS has observed that clinical work (including diagnosis) may be less concerned with resolving uncertainty than other forms of scientific work, because doctors, unlike other scientists, are not engaged in producing universal facts. Instead, Mol argues, doctors work to produce diagnostic knowledge primarily to situate what they do (2002). In Mol's work on atherosclerosis, disease is ontologically multiple, which means that different versions of the 'same' (ontologically multiple) disease may co-exist in different sites. Mol shows atherosclerosis to exist as pain on walking in the clinic and as a clogged artery in the laboratory. Different versions of disease need not be resolved to enable action because they can be co-ordinated across sites according to what Street calls 'different ordering practices' (2011, p. 818). In Mol's analysis, the central question of clinical work, the ordering practice at stake, is 'what to do' (2002, p. 69). Different ontologically multiple forms of disease are co-ordinated towards this question. The primary activity of clinical work is establishing 'what to do' rather than 'what is wrong'. As Street argues, commenting on Mol's work, a diagnosis is suspected from the moment the HCP recognises the specific enactment of the disease they expect to find (2011) but it is only once the HCP establishes that they can do something about it that uncertainty is resolved and a diagnostic label is produced. The vascular surgeon looks for pain when walking, but when confronted with a patient who describes pain on resting, he shrugs his shoulders and discharges the patient (Mol, 2002, p. 43). It is not the production of a diagnosis that resolves uncertainty, but the decision of what will be done, at which point a diagnosis is settled and produced. Importantly, as Will highlights, Mol does see this as way of working, which is so comfortable with multiplicity and adaptability to individual cases, as threatened by other medical or scientific rationales, specifically citing clinical epidemiology (2018b, p. 295). This suggests that different ordering practices can overwhelm the orientation of clinical work towards 'what to do,' instead ordering medical work around different priorities.

Street's exploration of diagnosis takes the resource impoverished context of Madang Hospital in Papua New Guinea. In this setting, Street argues that action is 'correlated with what is feasible, and then attenuated in relation to patients' responses to particular treatments' (2011, p. 824). Similarly to what Rasmussen et al. and Mol describe, amidst uncertainty, HCPs situate their action in what they perceive to be best for their patient. But unlike what Rasmussen et al.

FIGURE 1 NICE/UKHSA diagnostic algorithm for UTI in primary care. Crown Copyright 2020 UKHSA. Licenced for reproduction under the Open Government Licence v3.0.

and Mol describe, the doctors never close uncertainty by presenting a disease category and do not present the diagnostic sequence described above. Importantly though, the HCPs in Madang Hospital do not valorise this way of working. Street reports that the doctors justify their work against the suspected disapproval of the 'western doctors who were obsessed with diagnosis' (2011, p. 825). They notably describe this 'tinkering' work (Mol, 2008) as doing 'what they can' (2011, p. 825). This is what it takes 'to be a good doctor here' (2011, p. 825) but the doctors make a distinction from 'what they had been taught in medical school, or during their training in Australia' (2011, p. 825). This way of doing medical work reflects the best interests of their patients given heightened uncertainty attributable to global inequalities in healthcare provision, but it clearly causes some professional anxiety. In a just world, it would be better 'doctoring' to produce a diagnostic category.

Across these cases, there is a common theme of HCPs responding to uncertainty by producing a diagnosis after deciding what would be in the best interest of the patient. HCPs produce a diagnosis of condition X to justify what is to be done. What is to be done is resolved first, in advance of the production of the diagnostic category. This is a rupture from the sequence presented in the algorithm, where the identification of disease via a diagnostic category is a pre-cursor to what is to be done. The work cited above (Hobson-West & Jutel, 2020; Rosenberg, 2002; Whooley, 2010), including Street's example of an exception, situates the presentation of a diagnostic sequence which flows from symptoms to diagnostic category to treatment decisions in the professional concerns of HCPs involved.

Drawing on these insights, I explore how clinical care for bladders is co-ordinated and routinised in the NICE/UKHSA diagnostic algorithm for UTI in primary care (Figure 1) (UKHSA, 2002) and documents of its rationalisation (UKHSA, 2020), alongside accounts from HCPs. In the first section, I show that, amidst uncertainty, the diagnostic label of UTI (the nail) is often a *post hoc* justification of a treatment decision about whether to prescribe antibiotics (the hammer). In other words, as is a common theme in the work cited above, the question of 'what to do' is resolved prior to the question of 'what is wrong' and then condition X is produced to justify what is to be done. Whilst this way of working is commonly identified as a way to manage uncertainty by acting in the best interest of the patient, here the question is somewhat different. In the co-ordination of care visible in the diagnostic algorithm, the primary question is whether to prescribe antibiotics, rather than 'what to do' at large. A diagnosis of UTI, or the absence of a diagnosis of UTI, is then produced *post hoc* in order to justify the decision about whether to prescribe antibiotics or not. My argument therefore picks up work which has shown how diagnostic steps may be re-ordered, omitted or elided (even as the diagnostic process can be rationalised *post hoc*). But previous work has shown diagnosticians responding to uncertainty by enacting diverse and sometimes innovative actions in the (perceived) best interest of their patient. For example, Mol highlights a sensitivity to difference and individual variation in clinical work, with incompatibilities co-ordinated towards what to do for the patient. For Rasmussen et al. also, actions in the best interest of a patient can be diverse, ranging from the material effects of insurance claims to phenomenological meanings of identity work. Street highlights the 'attenuation' (2011, p. 824) of HCPs' actions in the best interest of their patients, again demonstrating a diversity of actions with which to experiment for individual patients. In this case, it is my contention that diagnosticians respond to uncertainty by resorting to a decision-making process around antibiotic prescription. Although HCPs may still be acting in the best interest of their patients by doing what they perceive to be the best of the two predetermined outcomes (to prescribe or not to prescribe antibiotics), this narrowing of

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available actions reflects both pessimism about what might be done and, I suggest, a deviance from normal clinical practice.

Subsequently, I explore why this might be, why ontological and epistemological questions have been raised in this way and show that the diagnosis of UTI is very closely related to the prescription of antibiotics, as a nail to a hammer. I explore the consequences of this way of co-ordinating diagnosis and care for different groups such as HCPs, policymakers working on AMR and patients, and thereby demonstrate the significance of my argument: what lies in between 'what to do' and 'whether to prescribe antibiotics.' Lastly, I consider the importance of the presentation of UTI as a diagnostic category which precedes 'what to do' through the pictorialisation and narrativisation of such a diagnostic sequence in the algorithm. This article therefore builds on sociological work around diagnosis to contribute an argument that AMS agendas can intervene in clinical diagnosis in ways which may go beyond the expected and keenly anticipated effects. Ultimately, I argue that this way of doing diagnosis pulls UTI out of other diagnoses because of its relation to antibiotics, which may perversely foreclose other ways of caring for painful bladders.

METHODOLOGY

Institutions often enact themselves through documents which attempt to standardise and co-ordinate work across space and time. The complex ways that standardisation documents not only reflect but also participate in reality have been extensively explored in many different theoretical traditions (Bowker & Star, 2000; Sinding, 2010, p. 1658) and it is a rather self-evident point that clinical policy does not have a straightforward relation to practice. Mol's praxiographic approach therefore 'privilege[s] practices over principles and stud[ies] them ethnographically' (2002, p. 33).

Here, the practice under study is not the practice of diagnosis as co-ordinated by the algorithm, but the practice of how the ontology of diagnosis has been organised by the guideline authors in order to enact certainty amidst high levels of uncertainty. Therefore, the successful translation of policy-mandated practices into practice is not a concern of the analysis here, but the selection of such practices is. I employ Timmermans and Berg's concept of a clinical practice guideline as a 'co-ordination device' (2003, p. 98), alongside Mol's praxiographic approach, to heed Weinberg's call for more empirical grounding and less metaphysical abstraction about what is at stake in doing diagnosis (2021).

I did this by analysing, at every step of the algorithm, which ontological and epistemological questions have been raised and valued in practice by authors of the guideline and its rationale, in order to provide the answers to the next step. Thus, I was able to elucidate the 'local relationships people draw between the epistemology and ontology of disease' (Weinberg, 2021, p. 377) and from that draw conclusions about local values and priorities.

Where the rationale included taken-for-granted logics, I resorted to interview data as a supplementary data set to further explore the details of certain practices (Rapley & Rees, 2018, p. 383). Interview data from semi-structured interviews with microbiologists was selected from a large data set of interviews, including patients, diverse specialisms of HCPs and other stakeholders in the issue of UTI and AMR. These interviews were selected for their explication of the practices behind the 'black boxed' logics (Latour, 1987). Analysis of this interview data took place in Nvivo using a grounded theory approach to code development (Charmaz, 2008). The microbiologists all worked at consultant level within the UK National Health Service and

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were interviewed online from June 2020–February 2022. Ethical approval for the study was granted by a university research ethics committee.

ORDERING PRACTICES IN THE CLINIC

Here, I look at how diagnosis is co-ordinated and rationalised in the algorithm, drawing on Mol's account of how different versions of disease can be co-ordinated to an (ontologically multiple) one (2002). I argue that the algorithm first orientates the diagnostician towards a decision about whether to prescribe antibiotics or not, and then provides (or withholds) a diagnosis of UTI in order to resolve uncertainty in this decision.

This algorithm is mobilised in women under the age of 65 who are not pregnant, do not suffer from recurrent UTI and do not use a urinary catheter. In the clinic, diagnosis of UTI in this patient group involves two chief means of identification: clinical history and, if there is more clinical doubt, a urine dipstick test. The former emerges from a discussion between the HCP and the patient where the patient may be asked about their symptoms. Care is co-ordinated so that UTI in this patient group can be diagnosed entirely clinically (from what the patient says or the diagnostician observes) when patients say things which describe at least two of three key symptoms/signs: dysuria (pain on urinating), new nocturia (newly waking at night to urinate) and urine cloudy to the naked eye (UKHSA, 2020). These symptoms can overlap with other conditions and so the diagnostician must also rule out urethritis, sexually transmitted infection and vulvovaginal atrophy. They can do this by asking about the onset of menopause, vaginal discharge, irritation in the urethral area and by taking a recent sexual history. This is a description of routine diagnostic work, and it is important to note that a large proportion of UTIs are diagnosed in this way in UK general practice.

Sometimes, there is more clinical doubt when symptoms are not, or are not perceived to be, what is expected. With the information provided from the clinical process, the algorithm instructs the HCP to enrol a urine dipstick in the process of diagnosis when fewer than two but at least one of the three key diagnostic signs are understood by the HCP to be present.

Notably, a urine dipstick does not give a positive or a negative test result for UTI. The dipstick tests for the presence of nitrites, red blood cells and leukocyte esterase in the urine. One measure may be negative, another positive, and neither needs to be discarded to make sense of a single diagnosis. Mol argues that signs and symptoms are co-ordinated towards a disease to-be-treated (2002, p. 70). A positive test result for one measure is one reason to treat, two another, three another still. The addition and subtraction of clinical signs/symptoms and dipstick results is joined by other additions or subtractions. HCPs are advised to consider other factors in deciding how to treat. These include severe symptoms (addition), pregnancy (addition) and a morning sample (addition). The vice versa would be subtractions. These factors are added or subtracted to the consideration of whether to treat or not, and whether to treat immediately or to 'watch and wait.'

Looking back at the diagnostic algorithm, the labels in white boxes 'UTI likely', 'UTI equally likely to other diagnoses' and 'UTI LESS likely' are not straight-forwardly related to the action advised. The various objects are signifiers of themselves, not of UTI (a sign of a nitrite is a sign of nitrite). It is the addition and subtraction of these signs which are co-ordinated to answer the question of what to do, rather than the question of 'what is wrong' implied by the representational language of 'UTI likely'.

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Following Mol's argument then, the HCP is engaged in the task of enacting a 'composite object' out of the 'disease to be treated' (Mol, 2002, p. 70). Note that the HCP has reached for the possible diagnosis of UTI from the start of this routine; the diagnostic pathway is labelled 'Flowchart for women under 65 years with suspected UTI' (UKHSA, 2002). But amidst diagnostic uncertainty, it is the multiple potentially contradicting signs of a UTI-that-should-be-treated or not that co-ordinate action and resolve uncertainty. When there is diagnostic uncertainty, as there is here in diagnosing UTI with this diagnostic algorithm, the question of 'what to do?' is resolved before the question of 'what is wrong?'

HOW ARE SIGNS SELECTED? LOCAL QUESTIONS AND VALUES

But how are signs selected? After all, most urine dipsticks test for a lot more than red blood cells, nitrites and leucocyte esterase. Meanwhile, symptoms of UTI can be much more various than just dysuria, new nocturia and urine cloudy to the naked eye. When Mol describes addition and subtraction, she does not account for what counts as an addition or a subtraction, and in which combination. I argue that this question of the selection of signs tells much about which ontological and epistemological questions are relevant and valued locally here.

The published rationale for the development of the diagnostic pathway explains that signs are calibrated around which ones have the most predictive value of a 'microbiologically confirmed UTI' (Little et al., 2010; UKHSA, 2020, p. 23). This is done by validating urinary signs and symptoms, as well as dipstick results, against another diagnostic technology: the MSU culture. Percentage figures are provided of the likelihood that a patient presenting with a specific sign or symptom, or combination, will have a 'microbiologically confirmed UTI'. There is a relation here between the question of whether a patient would benefit from antibiotics, and whether they have a bacterial urinary infection. Here, I explore the nature of this relationship.

As the diagnostic algorithm appears to use signs and symptoms as a signifier for the 'microbiologically confirmed UTI' underneath, then we could expect that revealing biological reality via a MSU culture would be the most accurate way to do diagnosis. The signs and symptoms in the diagnostic algorithm therefore begin to look like proxies for what is impossible in the context of a general practice consultation: the MSU urine culture. The proxy signs and symptoms seem to predict whose urine would sprout a significant growth on culture. If this were the case, the problem would look like innovating ways of bringing the lab closer to patients. With such a problem resolved, we could more accurately know which patients 'have a UTI' in advance of prescription and more accurately target antibiotics. Indeed, much AMR policy is concentrated on either innovation in rapid diagnostics (NICE, 2022), or in more effectively matching those whose urine would sprout significant growth to those who should be prescribed antibiotics (Butler et al., 2017). This would involve resolving the question of 'what is wrong' prior to the question of 'whether to prescribe antibiotics', a sequence depicted in the diagnostic algorithm and yet contrary to what I have argued is at stake so far.

In the next section, I look at how, in the lab, microbiologists attempt to emphasise the ill effects of establishing 'what is wrong' via the MSU culture data they produce, prior to establishing what is to be done. Instead, they attempt to enrol colleagues who are closer to the patient in the task of first establishing whether the patient should be treated or not. This is the work of specifying the relation between the two ontological questions of if the patient has a UTI and if they would benefit from antibiotics.

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ORDERING PRACTICES IN THE LAB

In the lab, clinical microbiologists perform the gold-standard diagnostic technology for UTI: the MSU culture. In this setting, with none of the impediments of the distance from the lab in general practice, we could expect diagnostic certainty if the question at stake were 'what is wrong?' And yet, all of the microbiologists I spoke to emphasised ill-effects of resolving uncertainty via urine culture results. Establishing 'what is wrong' via the medium of culture, prior to the resolution of the question of 'whether the patient would benefit from antibiotics', caused problems for care.

Many of the microbiologists I spoke with told me about experimenting with different ways of enrolling other HCPs into adding other considerations to positive/negative urine culture results. For this reason, the report that is sent back from the lab to where the patient is varies from site to site as clinicians tinker with different ways to best achieve the task of enacting a composite object of a 'disease to-be-treated.' For example, Emily, a clinical microbiologist, told me that in her lab:

> We've changed things, like a few times over the year we've dabbled with a few bits and pieces. Like for example not reporting any susceptibility results on certain samples or patient groups and I still do that occasionally.
>
> (Emily)

Emily's reference to '*not reporting susceptibility results*' refers to evidence that reporting susceptibility results is a strong cue for prescribing regardless of clinical need (Langford et al., 2021; Tebano et al., 2020). The diagnostic algorithm for UTI starts with a warning: 'do not treat asymptomatic bacteriuria in non-pregnant women as it does not reduce mortality or morbidity.' Emily therefore attempts to prevent the resolution of diagnostic uncertainty via growth on the culture plate. Instead, diagnostic uncertainty is resolved via the enactment of the 'UTI-to-be-treated', a composite object made up of much more including symptoms, '*certain samples*', different '*patient groups*', bacterial growth on culture plates and potential treatments.

As the rationale for the development of the diagnostic pathway explains, the signs were selected against the MSU culture because 'no symptoms or signs or combination was able to confirm UTI with absolute certainty [...] Therefore, the steering group discussed and agreed that a strategy of using a combination of a clinical score and urine dipstick will optimise the correct use of antibiotics (UKHSA, 2020, p. 23). Therefore, urine dipstick results and signs and symptoms are not proxies of a urine culture in revealing 'what is wrong.' Instead, the HCP looks for the signs and symptoms that predict whether the patient will benefit from antibiotics. As I noted in the introduction, diagnosis of UTI is clinically problematic. But the diagnostic algorithm does not intervene in diagnostic uncertainty by attempting to resolve the question of whether the patient has a UTI or not. Instead, as I have shown is common across social scientific analyses of diagnosis amidst uncertainty (Mol, 2002; Rasmussen et al., 2023; Street, 2011), diagnosis is co-ordinated towards determining what action should be taken. Indeed, clinical microbiologists Alice and Tom, independently of each other, both identify antibiotic treatment as useful for diagnosis of UTI:

> ***Tom***: If you're really sure you're getting better with antibiotics, then great [...] we suspect that 20% of infections are culture negative, we don't know why that is. So I'm not too...you

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know, just because you can't grow bugs, I don't really have a problem with saying they do have...they might have an infection.

Alice: From my point of view I always say a really good test of whether or not you've got the right diagnosis is if they get better on the antibiotics.

Uncertainty is sustained over a long period here and is ultimately resolved, for Alice and Tom, by clinical response to antibiotic treatment. We might consider that what they identify as the work antibiotics do in revealing if '*they might have an infection*' or '*whether or not you've got the right diagnosis*', is the work of demonstrating whether the patient would benefit from antibiotics. For Alice and Tom as microbiologists specialising in antimicrobial treatment, but also in the ontology of the diagnostic algorithm more broadly, the question at stake in doing diagnosis of UTI, more specifically than 'what to do', is whether the patient would benefit from antibiotics or not. The clinical work of doing diagnosis here is not broadly engaged in answering the question of what to do to make patients feel better, but more specifically, whether antibiotics would help relieve the problem, prior to the question of whether they 'have a UTI.' However, a diagnosis of UTI may then be produced, in order to justify prescription or as here, to rationalise clinical response.

PRESENTING A DIAGNOSTIC CATEGORY: UTI

Indeed, the likelihood of a patient 'having a UTI' is addressed in the algorithm. And it is visually presented before the 'action suggested', contrary to the ontology I have argued is at stake. When a patient consults a diagnostician with relevant urinary complaints, Mol's analysis says that a HCP is already looking for signs specific to a UTI because that is what they expect to find. This routine of reaching for UTI as a diagnosis and expecting to find it when presented with urinary symptoms is pictorialised and narrativised in the diagnostic algorithm labelled 'Flowchart for women under 65 years with suspected UTI' (UKHSA, 2002). In Mol's terms and the terms of the pathway, UTI is already suspected in this patient group by the time the diagnostician has reached for this diagnostic routine. I have shown that the signs looked for are signs of the likelihood that the patient's symptoms will be relieved by antibiotics (although this does have a relation to the question of if they 'have a UTI'). The HCP must enact a UTI-to-be-treated out of addition and subtraction of signs. In this case, the selection of relevant signs is neither based on the UTI which lies there underneath nor merely on the question of what to do, but on the likelihood that antibiotics will help relieve the problem.

However, the diagnostic algorithm uses language which claims representational knowledge: 'UTI likely', 'UTI equally likely to other diagnosis', 'UTI LESS likely.' Rather than understanding diagnosis as an iterative progression where treatment decisions are the product of first establishing what is wrong, I found that, in this case at least, the process is inverted; the production of diagnostic knowledge follows from decisions about whether to prescribe antibiotics.

To this end, the various patient groups on the algorithm, which are presented according to the likelihood of 'having a UTI', can instead be understood in this way.

Patient group 1: 'UTI likely': A decision to prescribe antibiotics, based on the co-ordination of many different factors, including patient group, symptoms, symptom severity, potential treatments, pregnancy and timing of the urine sample, may be justified via the production of the diagnostic category of UTI.

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Patient group 2: 'UTI equally likely to other diagnosis': When there is uncertainty about whether the patient stands to benefit from antibiotics more than they stand to be harmed, this is reflected in the presentation of sustained diagnostic uncertainty.

Patient group 3: 'UTI LESS likely': A decision not to prescribe antibiotics may be justified via the presentation of representational knowledge about the absence of UTI.

In the following section, I will explore why this may be, why the separate but related ontological questions of if the patient 'has a UTI' and if they stand to benefit from antibiotics have been ordered and co-ordinated in this way. I ask why the algorithm presents the diagnostic categories as preceding suggested action if, as I have argued, the diagnosis is produced *post hoc*.

WHY IS DIAGNOSIS CO-ORDINATED IN THIS WAY?

We should take seriously the achievements of this way of doing diagnosis. First and foremost, doing diagnosis in orientation to the potential to benefit from antibiotics makes UTI patients out of people in group 1. This group consults with symptoms which seem likely to be relieved by antibiotics, at a distance from the gold-standard diagnostic technology against which likelihood to benefit from antibiotics is calibrated (MSU culture) and become UTI patients via the prescription of antibiotics. This is an achievement of clinical care amidst diagnostic uncertainty, relieving symptoms and safely and effectively managing infections. When a person makes contact with medicine because they are experiencing painful and/or intrusive symptoms and becomes a UTI patient through identification as being likely to benefit from antibiotics, this is a moment of profound recognition between a patient and a diagnostician.

In a similar way, this way of doing diagnosis identifies patients in group 3 as unlikely to benefit from antibiotics, and then withholds from them the diagnostic category of UTI. In the context of global approaches to AMR, which understand the problem to be one of excess, as I sketched out in the introduction, this identification of those unlikely to benefit from antibiotics is a success. A keenly anticipated effect of this way of doing diagnosis is the reduction of antibiotic prescribing, subsequent reduction in AMR microbial reservoirs and, crucially, prevention of the harms of antibiotics to the individual, which have historically been underestimated (Langford et al., 2019, p. 3).

Although identifying this group as unlikely to be benefit from antibiotics is intended to discourage antibiotic prescription, I suggest that there are unintended effects of doing diagnosis in this way. That antibiotics are often prescribed to people unlikely to benefit from them is visible in data which shows a high level of antibiotic prescribing for UTI, without relevant signs (Smith et al., 2018). I argue that a routine of diagnosis that is so tightly orientated around whether to prescribe antibiotics or not makes it hard to do anything other than prescribe antibiotics, even for people with painful bladders who have already been identified as unlikely to benefit from antibiotics. The algorithm therefore reinscribes the process through which if all you have is a hammer then everything has to be a nail. When signs do not add up to a UTI-to-be-treated, the flowchart ends with a recommendation to 'reassure that UTI less likely' and to 'consider other diagnos'. No disease-to-be-treated has been successfully achieved, only a disease-not-to-be-treated: antibiotics will be not prescribed for a UTI.

For patients, if there are no symptoms, no action is unproblematic. But when there are symptoms, as there are in this group which started from 'urinary signs and symptoms', then there is also nothing to be done because the diagnostic routine is orientated around whether to prescribe antibiotics or not. When there is nothing to be done for a patient in pain, in a highly

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uncertain diagnostic process orientated around whether to prescribe antibiotics or not, I argue that this is a mechanism through which antibiotic prescribing is ultimately sustained. AMS interventions that pull UTI out of other urinary symptoms because they are primarily concerned with the question of whether to prescribe antibiotics or not, may perversely work to foreclose other ways of caring for painful bladders.

There is also very little in the algorithm to discourage prescribing for this group in a process highly orientated around antibiotic prescription. Compared to the aforementioned emphasis on the harms of prescribing for asymptomatic bacteriuria 'Do not treat', there is little emphasis on the potential harms of prescribing in this group. It might not be too much to say that the algorithm is somewhat permissive of antibiotic prescribing in this group in ways which preserve clinical autonomy (Freidson, 1989; Timmermans & Berg, 2003, p. 84) in the face of uncertainty. An antibiotic prescription and the foreclosure of other causes of symptoms is one potential outcome of this. But similarly, as the guidance around UTI and antibiotic prescription runs out of course 'UTI less likely, Consider other diagnosis', the referral back to clinical autonomy and expertise may represent an opportunity for further clinical exploration of other causes of urinary symptoms.

There is a fourth patient group in addition to the three I have presented above. This is a group who are presented with the diagnostic category 'UTI likely' but are not, on the balance of multiple factors co-ordinated towards the potential to benefit from antibiotics, prescribed antibiotics. For example, in the co-ordination of signs around the question of whether to prescribe antibiotics or not, a woman under 65 with dysuria, new nocturia and cloudy urine (addition, addition, addition) may be experiencing mild symptoms (subtraction), may not be pregnant (subtraction) and may therefore still stand to be harmed by antibiotic treatment more than she stands to benefit. It may be suggested to this woman to 'watch and wait', to engage in self-care and she may not end up taking antibiotics.

The disruption of a straightforward relation between diagnosis of UTI and antibiotic treatment, the disruption of the relation between the hammer and the nail, has been a key aim of AMS policy. Here, it has been considered important to produce a diagnosis of UTI, but this need not have a relation to treatment. The process of diagnosis has ascertained that she is unlikely to benefit from antibiotics more than she stands to be harmed as a separate, but related, ontological question to the question of whether she 'has a UTI.'

In discussions about AMS interventions around UTI, there is much concern with validating patients' experiences of UTI, whilst separating the diagnosis from the need for antibiotics. This is seen as important because women may be 'particularly vulnerable to feelings of not being taken seriously when their doctor proposes a strategy of no antibiotic or delayed antibiotic' (Leydon et al., 2010, p. 5). Therefore, a diagnosis of UTI is produced here for this reason that patients may feel they are not taken seriously if they are told that they need only to engage in self-care practices and no diagnostic category is produced. The patient is offered therapeutic recognition similar to group 1, but this is achieved via the production of a diagnostic category, rather than the production of an antibiotic prescription. As in the other groups, the diagnostic ontology is re-ordered: the diagnostic label of UTI is produced to justify what has been decided, and that antibiotics will not be prescribed. For, as Leydon et al. note, it is when a 'doctor proposes a strategy of no antibiotic' that patients may feel dismissed. The diagnosis has been produced after the decision not to prescribe antibiotics in order to justify and in some ways, facilitate, that decision. Here then, similarly to what Rasmussen et al. describe, the diagnosis

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not only succeeds the resolution of what needs to be done, and justifies it, but also participates in it. There is a re-ordering of diagnostic steps, but also an elision or a blurring.

This difference between group 3 and group 4 draws out the precise relation between the separate but related ontological questions of whether the patient has a UTI compared to whether the patient will benefit from antibiotic treatment. Group 3 and group 4 are both identified as unlikely to benefit from antibiotics more than they may be harmed, and yet group 4 is presented with a diagnostic category of UTI, while group 3 is presented with no diagnosis. Group 4 have been protected from the potential harms of antibiotic overtreatment. This diagnostic ontology therefore functions well for this (no-doubt large) group the algorithm was designed for.[3] However, by orientating the diagnostic process so closely around the question of establishing who will benefit from antibiotic treatment, it may be that other ways of caring for group 3 are foreclosed. Good care for group 3 must take place outside of this algorithm, which from the start has reached for UTI as a diagnosis.

There are different consequences of doing diagnosis in this way for different groups. Herein lies the significance of my argument, what lies in between 'what to do' and 'whether to prescribe antibiotics.' As regards the complex relationship between policy and practice, but also the care that may be enacted by a tinkering clinician once the guidance here has run out of course, patient outcomes are not to be anticipated. However, I have here laid out some mechanisms through which antibiotic prescribing may be sustained or disrupted, and some potential consequences.

CONCLUSION

I have explored the ontology of the process of diagnosis of UTI as co-ordinated by the UKHSA/NICE diagnostic algorithm before exploring some reasons why diagnosis has been co-ordinated in this way. In 1987, medical sociologist Roisin Pill argued that the insertion of microbiological diagnostic technologies in general practice led to an approach which centred confirming or excluding UTI, with too little attention paid to other explanations. Over 35 years later, with increased policy attention on experiences of cystitis due to concerns about AMR, I observe a similar effect of the insertion of technologies of AMS into diagnostic uncertainty. I argued that the diagnostic category of UTI is produced *post hoc* to rationalise and participate in decisions about whether to prescribe antibiotics or not.

Such re-ordering, elision or blurring between diagnostic steps has often been noted in medical sociology and STS amidst clinical uncertainty when diagnosticians act in the (perceived) best interest of their patients. In the case I offer here, HCPs may still be in acting in the best interest of their patients, but they are guided to do this by doing what they perceive to be best of the two pre-determined outcomes (to prescribe or not to prescribe antibiotics). This provides a rationalisation of what has already been decided, projecting certainty amidst uncertainty. Moreover, the orientation of diagnosis around the question of whether to prescribe antibiotics or not provides a deductive certainty amidst uncertainty because possible outcomes have been pre-determined (Timmermans & Berg, 2003, p. 90).

This way of closing uncertainty reflects both pessimism about what might be done and, I suggest, a deviance from the tinkering work (Mol, 2008) of normal clinical practice. This case therefore makes a contribution to the sociology of diagnosis which recalls Mol's warning that the introduction of different ordering logics may impoverish clinical medicine. An AMS logic which pulls UTI out of other salient diagnoses because of its relation to antibiotics may *promise*

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to more effectively target antibiotics but also threatens to sustain inappropriate prescribing by ordering medical work around the question of whether to prescribe antibiotics rather than the broader question of what to do. HCPs can thereby participate in a routine whereby it is difficult to enact a diagnosis other than UTI because AMS agendas mean that the question of whether to prescribe antibiotics is highly valued. In other words, when only a hammer appears available, it is difficult to do anything other than hammer a nail.

In my view, the co-ordination of diagnostic uncertainty around antibiotic use in this algorithm reflects broader pessimism in approaches to AMR more generally. As Chandler notes, global approaches to the problem of AMR have primarily framed it as a problem of antibiotic overuse (2019, p.4). AMS takes a conservationist approach to antibiotic resources, aiming to drive down prescription with pessimism and depression about what else might be done for patients. An alternative would be a greater experimentation with new (or indeed old) ways of caring for painful bladders. Creative practices, including using, but also beyond antibiotics, could be opened up if we ensured that the question at stake were not 'what is wrong?' or whether to prescribe antibiotics, but 'what to do?' This would require a greater openness to prolonged uncertainty but would also represent a return to more clinical ways of working, a greater confidence in clinical skill itself. If it is not yet clear what such alternative practices may be, we could start by looking to the practices of the women of group 3 as they persevere in the task of caring for their poorly bladders amidst health care highly orientated around antibiotic use.

AUTHOR CONTRIBUTIONS

Eleanor Kashouris: Conceptualization, formal analysis, funding acquisition, writing-original draft preparation, writing-review and editing.

ACKNOWLEDGEMENTS

I would first and foremost like to acknowledge the guidance and mentorship of Dr Gethin Rees at Newcastle University in the process of preparing PhD work for publication. I am grateful for the support of the Foundation for the Sociology of Health and Illness in a Mildred Blaxter Postdoctoral Fellowship. I am indebted to Professor Bobbie Farsides, Dr Ulla McKnight, Dr Liz McDonnell and Professor Catherine Will at the University of Sussex for supporting the work upon which this article is based, as part of the Wellcome Trust funded Marginalisation and the Microbe project (214954). Many thanks to the Centre for Biomedicine, Self and Society at the University of Edinburgh for close engagement following a presentation of this work, especially Dr Chase Ledin, Professor Martin Pickersgill, Professor Steve Sturdy and Dr Haris Haseeb. I would also like to thank Dr Tom Lewis for reading an early draft and for always reminding me of the importance of uncertainty in this area. Finally, thank you to the two anonymous reviewers and to the editorial team, especially Professor Karen Lowton, for their time, feedback, and support. This work was supported by a Mildred Blaxter Postdoctoral Fellowship from the Foundation for the Sociology of Health and Illness and the Wellcome Trust (grant number 214954 PI Catherine Will).

CONFLICT OF INTEREST STATEMENT

The author has none to declare.

DATA AVAILABILITY STATEMENT

Due to ethical concerns, the supporting interview data cannot be made openly available.

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ETHICS STATEMENT

Ethical approval for the study was granted by the University of Sussex Social Sciences & Arts C-REC. The approval number to interview health-care practitioners was [ER/CW82/10].

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ENDNOTES

[1] Social scientific studies of AMR have ranged extensively and widely over the past decade, see: Will (2018a), Landecker (2016) Chandler (2019) for some overall approaches.

[2] For explorations of other ways of doing diagnosis, see Bell et al. (2024).

[3] See Hammond et al. (2020) for an evaluation of English national AMS programmes in practice.

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How to cite this article: Kashouris, E. (2024). 'When all you have is a hammer, everything has to be a nail': Managing diagnostic uncertainty in urinary tract infection. *Sociology of Health & Illness*, 1–18. https://doi.org/10.1111/1467-9566.13803

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