The Local Universality of Veterinary Expertise and the Geography of Animal Disease

Dr Gareth Enticott

ESRC Centre for Business Relationships, Accountability, Sustainability and Society,

and

School of City and Regional Planning,

Cardiff University,

UK.

Email: enticottg@cardiff.ac.uk

Tel: 029 2087 6243

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Abstract

This paper explores the concept of 'local universality' in relation to the regulation of animal health. Protocols have come to play an important role in medical practice, standardising diseases and the expertise required to identify them. Focussing on the use of protocols to identify bovine tuberculosis (bTB) in England and Wales, it is argued that the decontextualised expertise inherent to protocols comes unstuck in practice. Using ethnographies of two veterinary practices, the paper instead shows how forms of situated veterinary expertise emerge in response to practical contingencies, thereby enacting different ontological versions of bTB. The development of these skills stems from the relationships that organise bTB testing as well as through informal work-based modes of learning. Although these practices vary from place to place and depart from the bTB testing protocol, it is variation in practice rather than uniformity that effectively allows the protocol to work. In conclusion, the paper discusses how the management of animal health may be assisted by a flexible rather than uniform approach to disease and veterinary expertise.

Keywords: Standardisation; Bovine Tuberculosis; Local Universality; Expertise; Vets; Medical Regulation; Animal Health.

Veterinary Practices and Protocols

It is a scene repeated daily across the farmscape of England and Wales: testing for bovine Tuberculosis (bTB). Cattle are driven out of their sheds. In small groups they are taken into a holding pen. Farmers wave their hands in the air, whistle and shout. Cattle are prodded with polypropelene piping and persuaded towards the restraining device known as the 'crush'. It is noisy. Gates are kicked, metal fences smash against each other as cows resist. Numbers on eartags are shouted each time cows pass through the crush. And amongst it all, there is a vet, working regularly, routinely, as instructed by a veterinary protocol, looking for disease.

This paper considers the role of the veterinary protocol in this sequence of events and its relations to disease and veterinary expertise. Protocols have come to occupy a significant role in the practice of medicine. They may take many forms: written instructions, diagrams, flow charts, or algorithms. Whatever form they take, they have the same goal: to 'guide medical personnel through a sequence of steps' (Berg 1997a, p. 1081). These steps, usually of diagnostic tests, come to enact a specific disease ontology (Law and Mol 2011): a version of disease that performs and is performed by a specific set of practices, materials, and expertise. Protocols enact disease, what it means to be a medical expert and the spatialities that allow disease to be managed across space to a greater or less extent (Latour 1988; Mol and Law 1994).

For animal diseases like bTB, protocols are extremely important. Historically, the purpose of testing for bTB was to protect public health: the disease can be passed between animals, but also to humans. The pasteurisation of milk and inspection of meat have largely resolved these problems. Now, the main purpose of bTB testing is connected to a set of international trade laws that aim to secure an international geography of agricultural flows from infection. In this, the protocol is vital, providing a legal standard of what bTB is and how it should be identified. But the

UK's place within this geography is under threat: bTB has become a serious animal health problem requiring constant veterinary surveillance. Routinely testing for bTB may help to prevent and secure membership of this international agricultural geography, but it costs the taxpayer approximately £100 million per year. Meanwhile, attempts to fully eradicate the disease in the UK have floundered amid opposition to controversial proposals to kill wildlife (specifically badgers) implicated in spreading the disease to cattle (see Enticott 2001, 2008). Currently, testing and slaughtering infected cattle therefore remain the only line of defence against bTB. When vets test for bTB, they act on behalf of the Government, explicitly agreeing to follow the testing protocol and in so doing, playing their part in patrolling the relations that enact this version of agricultural space and disease.

However, rather than a coherent and uniform geography of bTB, this paper suggests something different. In examining vets' attempts to enact the protocol in practice, the protocols' smooth and uniform versions of disease and veterinary expertise are replaced and transformed by the creation of informal and situated practices. The practice of testing for bTB reveals different versions of disease and veterinary expertise. But it also appears that the situated practices that enact these alternative ontological versions of bTB also hold the standardised versions of bTB together, allowing the bTB testing protocol to effectively 'work' even though it varies from place to place. Following Timmermans and Berg (1997), this is referred to as 'local universality': the idea that standards, protocols or ontologies are universal only through their ability to be adapted locally. To demonstrate this more fully, the paper uses ethnographies of two veterinary practices conducted in 2008-9[1]. They reveal how and why vets come to transform the bTB testing protocol to enact alternative veterinary identities and expertise from those performed by the protocol. In conclusion, the paper concludes by considering the contribution that local universality could make to animal health policy and regulation.

Testing for Bovine Tuberculosis

Cattle in the UK require testing for bovine Tuberculosis at various times of their life. Cattle that test positive (known as reactors) are removed from the farm and slaughtered. Those that remain are retested every two months until the farm is believed to be clear of the disease. The process to determine the presence of disease is outlined in precise detail in the bTB testing protocol within the European Union's Directive 64/432. In the UK, this protocol is synthesised into a set of step-by-step instructions for vets in Animal Health's[2] Operation Manual (2010). The protocol specifies that to diagnose the presence of bTB, the Single Intradermal Comparative Cervical Tuberculin Test – more commonly known as the skin test – should be used. The test compares reactions in the skin (that look like lumps) following the injection of avian and bovine tuberculin at the top and bottom of the neck of cattle. Three results can be determined: a 'reactor' is an animal whose skin thickness increases by more than 4mm; an 'inconclusive reactor' (or IR) skin thickness increases by between 2mm to 4mm; or a pass where the skin thickness increases by less than 2mm. To complicate matters, the test result can be interpreted at different levels of severity. Standard interpretation (as above) gives way to severe interpretation if disease is confirmed by finding visible lesions during the post-mortem of a reactor. In general, severe interpretation decreases the pass intervals by 2mm (for more details see: de la Rua-Domenech et al. 2006; Monaghan et al. 1994).

This protocol and the test it describes enact a specific ontology of bovine tuberculosis: what it is and what it takes to know it. Central to this version of bTB is precision. The protocol sets out in great detail how the test should be conducted and where the tuberculin should be injected. For example:

> ‘Tuberculin tests shall be carried out by injecting tuberculin(s) into the skin of the neck. The injection sites shall be situated at the border of the anterior and middle thirds of the neck. When both avian and bovine tuberculins are injected in the same animal, the site for injection of avian tuberculins shall be about 10 cm from the crest of the neck and the site for the injection of bovine tuberculin about 12,5 cm lower on a line roughly parallel with the line of the shoulder or on different sides of the neck; in young animals in which there is not room to separate the sites sufficiently on one side of the neck, one injection shall be made on each side of the neck at identical sites in the centre of the middle third of the neck…Injection sites shall be clipped and cleansed. A fold of skin within each clipped area shall be taken between the forefinger and thumb and measured with callipers and recorded. The dose of tuberculin shall then be injected by a method that ensures that the tuberculin is delivered intradermically. A short sterile needle, bevel edge outwards, with graduated syringe charged with tuberculin, inserted obliquely into the deeper layers of the skin may be used. A correct injection shall be confirmed by palpating a small pea-like swelling at each site of injection”.
>
> (Council of the European Economic Community 1964: 2.2.4 and 2.2.5.1)

This reliance on exact measurement and classification is unsurprising when one considers the origins of protocols. In charting the history of medical protocols, Berg (1997a, b, 1998) argues that protocols emerged from attempts to establish medical practitioners and medical practice as ‘inept’ and ‘cognitively deficient’ (Berg 1997b, p. 35) without a standard vocabulary, records and procedures – failings which a science of medical practice could address. By rendering medical practice more scientific, the advocates of protocols suggested that they would enhance the quality of care by ensuring greater compliance with standards based on current biomedical research (Kanouse 1989). At once, the protocol could help ensure the standardisation of medical practice whilst re-creating medicine as a science (Berg 1995).

The bTB protocol also reflects these concerns. The protocol therefore enacts the expertise required to know what bTB is as logical, rational and scientific. To do otherwise would be to guess, and that would be of great concern given that agricultural trade and human health rests on these diagnoses. But not any person possessing these forms of expertise can diagnose bTB: the protocol also enacts who is able to determine its presence. It makes clear that only an 'official veterinarian' can conduct the test who has been 'appointed by the competent authority of the Member State' (Article 2, 2 (I)). But allied to the scientific expertise required to identify bTB, the protocol performs a specific identity for the vet: not just any vet, but a scientific vet, a logical and rational individual who follows orders and sequences of events to the letter.

The protocol also enacts a geography of knowledge common to the practice of science (see Livingstone 1995). Protocols can be considered a form of 'inscription device' (Latour, 1987) that relationally establish order across and within space by standardising practices and behaviours therein (Murdoch 1998). For this to occur, there can be no distractions, no dissenting to the ordering of events: replicating tests must be possible (Shapin and Schaffer 1985). This demands a uniform agricultural space with no opportunity for variation or resistance to the protocol otherwise the test would no longer be scientific and it could not enact bTB. Thus, the protocol presents a version of agricultural space which is idealised and homogenised: a laboratory on a farm, free from any social or natural distractions to ensure that science can occur. Agricultural space is therefore flattened into what Latour (1988) would call a tightly aligned irreversible network where everything knows its place. This spatial flattening extends further: information flows consisting of bTB test results travel smoothly between farms, veterinary practices and Defra's Animal Health offices – the 'centres of calculation' that ultimately decide the fate of bTB infected cattle. It is this type of relational space that allows scientists and regulators to act at a distance in order to control and order animal health (Latour 1988).

Protocols and their Geographies

These enactments of bTB are central to the geographical aims of bTB regulation. But the scientific identities specified by the protocol are reinforced by other uses of the protocol. In 1997, the UK Government embarked on a 10 year experiment to resolve whether culling badgers could reduce levels of bTB (Krebs et al. 1997). The experiment compared levels of bTB in cattle in areas where badgers had been culled to those where they had not (Independent Scientific Group. 2007). The scientific credentials of the protocol were therefore reinforced: it was not just a diagnostic tool, but also a standardised methodology central to a scientific research project. This use of the protocol enacted new identities for those who administered it, endorsing again the scientific status of the vet.

The results of the experiment showed only mixed benefits but they were dependent on testing cattle in a uniform and appropriate manner – as described in the protocol. Yet barely mid way through the experiment concern arose that vets conducted bTB tests differently, that there was a variation in procedure: vets were not acting scientifically. Scientists involved with the project were worried: they suggested a need for 'standardizing the application of the test' to 'improve its efficiency' so that results were 'consistent' (Independent Scientific Group 2003: 58.6.4). These concerns fell largely on deaf ears, but events in 2005/6 were more significant. A calf on a small holding in South Devon tested positive for bTB but the farmer was not willing to let the calf be slaughtered, demanding a re-test and threatening legal action (BBC 2006). In reviewing the case, the local Animal Health office discovered that the test had not been conducted according to the protocol. In effect, the vet had not acted as a scientist: the test result could not be trusted and a re-test was granted. In fact, rather than the scientific discourse inherent to protocols, bTB testing seemed to be full of variation. Moreover, the scientific identity ascribed to vets could no longer be assumed. At least, if the protocol was defined by science, and science defined the expertise of vets, then this sequence of events defined veterinary expertise as something different.

These events had further implications. The then minister for animal health demanded a review of "the instructions and interpretative material and their use by [vets]' (Bradshaw, in HC 2006). The Government responded by attempting to impose rigour and order upon the bTB testing process by re-emphasizing the scientific nature of bTB testing (Animal Health 2008). If vets tested according to the protocol – if they acted as scientists – then farmers could not complain about the results of the test. Such an argument, however, misunderstands the nature of protocols and the situated practice of veterinary work. In the remainder of this paper, I present evidence to demonstrate how bTB testing is embedded within sets of heterogeneous relations – between vets, farmers, cattle, farm materials, diseases and technologies – the effect of which is to organise a range of different ways of testing for bTB. In this view, managing the balance of these relations represents the expertise of the vet, rather than the rigorous scientific identity suggested by the protocol. Moreover, it is precisely this expertise that allows the bTB protocol to work across space.

To make this argument more fully, it is helpful to turn to literature from science and technology studies and social studies of human medicine. Within this literature, the protocol as an 'inscription device' (Akrich 1992; Latour 1987) has received attention from those seeking to understand how medicine works in a social environment. Whilst protocols may promise to improve the quality of care received by patients, Berg (1997a) suggests that idea of scientific health care is compromised by four factors.

First, Berg argues that a protocol ignores the social reality of medical practice: that doctors and patients engage in social interactions in specific contexts which informs 'the credibility of the sources the data derive from – whether colleagues, patients, or diagnostic techniques' (1997a, p. 1083). Protocols assume this to be an irrelevance, but continual practical contingencies will exert greater urgency than protocols in medical practice. By contrast, protocols reinforce a tendency 'to perceive and describe the management of patients' trajectories as constituted by a sequence of individual formally rational decisions' (Berg 1997a, p. 1082). But this has two effects: it perpetuates the belief that medical failures are the responsibility of individuals rather than the shortcomings of institutions; and it means that research is not directed to uncovering why medical failures and variations occur, and the '(im)possibilities and (un)desirabilities of smoothing these out' (p. 1083).

Second, protocols can contribute to the 'illusion of the single answer' – that 'there is only one optimal intervention to every medical problem' (ibid.). This reflects the discourse of scientific expertise inherent to protocols, but other rationalities and social considerations can provide alternative appropriate courses of action. Third, Berg argues that protocols 'contribute to the loss of importance of information and interventions which are difficult to explicate and/or to quantify' (p. 1085). The difficulty of representing social circumstances and tacit assumptions within a protocol results in the foregrounding of the scientific and that which can be explicated. This creates a hierarchy of information, marginalising some medical workers whose information may be less 'hard' or less easy to formalise. Finally Berg suggests that attempts to formalise expertise as a means of gaining professional status may further erode the tacit knowledge crucial to medical decision making. Reliance on protocols can result in excessive bureaucracy, creating protocols that serve little purpose. What started off as an attempt to formalise and strengthen a profession might instead end up weakening it.

Given these limitations, what becomes of protocols, their diseases and expertise? If protocols attempt to exert uniform medical practice across space – or attempt to practice uniform space – how do they fare when faced with alternative realities? Their corruption may be inevitable: it is perhaps hard and unrealistic to see all medical actors blindly submitting to the domination of medical protocols, particularly when they are onerous (Berg 1997a). But corruption is likely to be the wrong word: disease may be multiple with different local contexts lending themselves to different diagnoses or versions of disease (Laet and Mol 2000). This is not a competition between disease ontologies, but as Mol and Law (1994) suggest, a matter of fluidity in which there are no clear boundaries between variations of disease in which 'normality becomes a gradient rather than a cut-off point' (ibid. , p. 659). This does not mean that protocols have no value at all, but that their transformation between contexts means they can continue to diagnose disease. For protocols, Timmermans and Berg (1997, p. 275) call this quality 'local universality' to reflect how standards are always transforming and emerging in and through localised negotiations and pre-existing material relations. The process of 'local universality' suggests that protocols can only function through the 'ongoing subordination and (re)articulation of the protocol to meet the primary goals of the actors involved' (p.291). In short, for protocols to 'work', there must be opportunities for leeway and discretion to ensure actors' cooperation. Thus, in Timmermans and Berg's case, the use of certain drugs, required by a protocol, are dropped when opposed by any member of the medical team for practical reasons. Local universality is therefore similar to Murdoch's (1998) conception of inter-twined spaces of prescription and negotiation. Here, prescription depends to a lesser or greater extent on negotiation: achieving prescription across and within space is only possible by allowing variations and negotiations around standards. Standardisation therefore occurs not from an irreversible network, but is only achieved in loose-fitting relations (Waterton 2002).

Protocols do not work because of the docile submission of medical personnel, but through their ability to actively manage its contingencies. This means deploying ad hoc interventions designed to keep standards more or less on track. The ambiguity of protocols can therefore work in their favour. In this way, protocols can direct medical practices in 'several locales at the same time', yet they are 'always also located as a product of contingent negotiations and pre-existing institutional and material relations. In sum local universality depends on how standards manage the tensions among transforming work practices while simultaneously being grounded in those practices' (Timmermans and Berg 1997: 297-8). This makes space for a different type of medical expertise: one that accommodates flexibility, intuition and indeterminacy, adapting itself to matters at hand rather than blindly submitting to technology – what Mol (2008) calls a 'logic of care'. As Wynne (1988) argues, technology and science are often unruly: its understanding derives from evolving practices which themselves are subject to constant change. This evolving form of expertise is in contrast to the de-skilled unthinking 'cook book medicine' of protocols (Berg 1997a, b). The need to evolve practices to fit contingent situations and make protocols work creates a different type of expertise. The workings of a protocol therefore emerge from a seemingly chaotic interaction of multiple trajectories which transforms both the expertise of medical personnel and the rules of the protocol. Thus, 'rather than being the product of ever increasingly tightened networks, medical protocols can coordinate activities over space and time because of the non-docility of the actants which populate these practices' (Timmermans and Berg 1997: 298).

Local universality therefore defines a type of situated expertise that revels in ambiguity. It is more than scientific, patching together a scientific test with the needs of patients, colleagues and other material contingencies. This type of expertise emerges within the relations that actors find themselves. For example, in writing about the failure of instruction guides to help photocopier technicians repair broken machines, Orr (1996) describes how expertise is developed by colleagues exchanging what he calls 'war stories' – accounts of work, to make sense of work. Through storytelling actors receive their 'real' training in learning how to deal with the ambiguity of technology. At the same time, telling and sharing these war-stories confers membership of a group identity that values emergent forms of expertise rather than one which is standardised within protocols. Lave and Wenger (1991) call this type of situated learning 'legitimate peripheral participation' in which learning about practice is replaced by learning about becoming a practitioner through emergent, informal oral-based, social modes of workplace learning. In the context of health care, Jordan (1989) shows how these noncanonical modes of learning help to preserve local identities and resist formal medical practices that do not fit social and practical contingencies. This informal learning therefore establishes and legitimises expertise that does not fit within the bounds of the protocol. It solidifies cultures of work, practices and expectations of 'normalised deviance' from abstract rules (Vaughan 1996).

Lave and Wenger suggest that situated learning also has a geography. Legitimate peripheral participation involves learning across ever-changing and multiple sites to varying degrees of engagement. But for some forms of expertise, proximity between places and actors may be more important than others. For example, Amin and Roberts (2008) suggest that the development of task-based forms of knowledge may benefit most from local face-to-face interactions. Thus, Orr (1996) describes how when technology did not follow the rules, alternative solutions emerged from colleagues' social interactions in different informal gathering points. This geography of expertise was also dependent on the client facing role of the technicians: their face-to-face relations meant that they could not simply give up when protocols could not be enacted out of both professional embarrassment, but also the need to maintain relationships with clients and work colleagues. Finally, this geography of expertise arises from opportunities created by 'social organisation' (Vaughan 1996). When work is distributed across different sites, this organisation can provide the space for innovative forms of expertise to emerge (Brown and Duguid 1991), partly because this organisation allows these new forms of expertise to remain invisible to those at other sites or their implications misunderstood (Vaughan, 1996). To put it another way, learning to managing the risks of animal disease can depend on an organisational geography which influences the contexts, relations and cultures in which health professionals must find ways of enacting a protocol.

Practicing Local Universality

How does local universality feature in the regulation of an animal disease like bTB? Despite the weight of international regulations governing agricultural space, does bTB continually shift between multiple versions of bTB enacted by protocols and other veterinary practices? If so, how are these transformations occurring and what does this local universality say about the geography of animal health regulation? To answer these questions, the paper turns to an ethnography of vets at work. Using a series of vignettes derived from field notes, the transformation of the bTB protocol and emergence of different versions of bTB is explored below.

Learning to Test

If local universality emerges in reaction to prescriptive learning, a good place to start is by considering how vets are officially taught to test for bTB. In the UK, vets wishing to undertake bTB testing must be appointed as an 'Official Veterinarian' (OV). Prospective OVs must attend a 2-day training course provided by Animal Health. The first day involves a brief lecture on the history of bTB, a discussion about the pathology of bTB and an outline of the various types of bTB tests. The rest of the day focuses on the skin test and interpreting its results. Vets are shown a series of slides detailing the skin test protocol and reminded of the importance of completing each of the tasks within the protocol and the consequences for the accuracy of the test if they do not. They are reminded that for each test they will need to certify that they have undertaken the test according to the protocol: a false declaration may lead to their suspension from bTB duties or all veterinary practice. After this first training day, the vets are free to conduct bTB tests on clients' farms. The second training day takes the form of a 'supervised test' with a Veterinary Officer (VO) from Animal Health. At the supervised test, the VO assesses the OVs technique and ensures that they are following the protocol.

Like many other forms of scientific training, the uncertainties of tests and tacit knowledge required to make them work is not discussed (Delamont and Atkinson 2001). Instead, as vets begin to test regularly, their interactions with animals and technologies in multiple sites of practice play a significant role in shaping the way they test. Physical proximity is essential to these forms of knowledge. From physically handling hundreds of different animals each day, vets come to understand the protocol is contingent and can be accomplished by dispensing with some elements or developing new practices to cope with different contexts. For example, cattle do not usually stand still when they are herded into a crush. The stress cattle are placed lead many to move suddenly and violently. Attempting to clip their hair, measure the skin thickness and inject all in the same place – as demanded by the protocol – can often lead to vets sustaining injuries. Instead these steps of the protocol are often ignored and workarounds developed. For some vets, the routine of injecting leads to an embodied understanding of when the tuberculin enters the skin by feeling the feedback in the injecting gun. Only when this feeling is absent do they palpate the skin as required by the protocol to check whether the injection was successful. Other embodied skills are developed through vets physical interaction with cattle, rendering the use of callipers as specified in the protocol redundant. Consider these fieldnotes:

'Im on my way back from testing 400 cattle with Michelle. Its taken all day, but not because she was rigidly following the protocol. At first Michelle started to test the cows using the callipers, but after 10 minutes or so she starts to use her fingers, squeezing the skin together, slightly rolling it between her fingers and then shouting out a skin thickness measurement for me to write down. In the car on the way back I ask her when did she first stop using the callipers and why? Michelle says that she hadn't actually been testing that long, but she could soon tell the skin thickness simply by the sensation of her grip on the callipers. It was as if her hand had become the callipers, but the measuring scale was no longer required. With her sensitive fingers, she now only used the callipers to calibrate her fingers at the start of each test.'

This practice could cause concern if cattle react to the injection – vets who adopt these procedures still want to be sure their finger measurements were 'right'. In this case, cattle that are borderline reactors or IRs, several neck measurements will be taken using callipers close to the reaction site to ensure that the neck thickness taken by hand were accurate and if not they will be changed. Using the callipers like this to help interpret the test results takes less time and helps ensure the cattle are less agitated. The constant repetition of testing also leads to the conclusion that there is no significant difference in skin thickness at different sites across the neck. This means that there is no need to measure or feel the skin at two different sites. However, this rule only applies to female cattle. Bulls and steers are treated differently. Experience tells the vet that the skin thickness rules no longer apply. Bulls have thicker necks and the measurement is also likely to vary in different places. Depending on his behaviour in the crush, the bull may therefore be the one animal for which the protocol makes sense. But it only makes sense from the experience and practice of testing. Finally, this constant repetition of testing also leads vets to learn the likely skin thickness of cattle according to their age, breed and sex. Some vets normalise skin measurements for cattle – for example, for some vets a Holstein dairy cow would always be about 7mm, so there is no need to measure each one. Other breeds, such as Herefords are more likely to be recorded as 9 or 10mm.

Cultures of testing

Whilst individual experiences play an important role in learning to test, they are also confirmed, shared and legitimised at different sites of practice – in particular, at different farms and the veterinary practice. It would be rare for more than one vet to attend a bTB test: the veterinary practice therefore provides an important site in which vets can talk to their colleague about the day ahead or reflect on the day just gone. During these moments, various stories may be exchanged about farmers, their cattle, their plans, injuries that they may have sustained or the tricky surgical procedures that they pulled off. These stories fill a variety of roles. They provide intelligence to other vets in the practice about farmers, either relating to the farmers' social life, or the condition of his animals. This intelligence is important because any of the vets may be called to the farm in an emergency and knowing what's going on can be of some help. The exchange of stories also creates and sustains a veterinary identity of what it means to be a vet. This identity is represented in the many and varied heroic accounts of accidents and near-misses with animals; vets' communitarian relationships with farmers; and vets' clinical problem solving and technical abilities. Stories about bTB testing also fill this role: the speed at which animals are tested help to shape vets' expected skills and how a bTB test should be enacted. Thus, bragging between vets over who holds the record for the quickest test and the most cattle tested in a day reveals a competitive streak between vets whilst enacting the bTB test as something that can, should and needs to be completed as quickly as possible: those tests that are not are the least desirable (see Enticott 2011). Ironically, though, these less desirable and 'dangerous' tests provide opportunities for affirming veterinary competence by heroic storytelling at the end of the day.

The result of these stories is to create different versions of the bTB test within veterinary practices. For new vets, these stories represent important learning opportunities, allowing them to get to grips with the problems of practice, learning to be a practitioner and enacting different versions of bTB. The emphasis on speed, and discussions on the facilities on each farm, their safety and adequateness, and the behaviour of their stock legitimises the failure to measure and clip, and to continue working as an 'heroic vet' in unsafe conditions. But these exchanges of stories that vets engage in at the end of each day can also contribute to the transformation of other aspects of the protocol. The lessons from these stories are not always explicit: they are often told subtly or kept partially secret from new vets but gaining access to them is part of becoming a practitioner. In the account of fieldwork below, we see how these informal work-based modes of learning are played out in different locations to normalise alternative ways of enacting the bTB protocol.

'Im in the car with Robert driving to read another TB test. The farm we're going to has had a lot of reactors in the past, but if there are none today then the farmer will be happy: he'll be able to sell up, but he can't until he's free from TB. This means it could be stressful – for everyone. Perhaps as a result, Robert is reflecting on an incident that happened last week at the end of a TB test we we're at. We'd tested 400: there were 4 reactors and 2 inconclusives (IRs). John – the farmer asks Robert what he is going to do about the IRs? He says he'd prefer it if they were reactors, that way he'll receive financial compensation from the Government. Robert isn't so sure. In the car he tells me he doesn't like lying about these things. John raises the stakes: he

says, ‘my take on it is that all this TB has caused me a lot of grief and its the Government’s fault, so this way I can get some money back ’. Robert sticks to his guns and tells him he can always sell them at a restricted market. But John tells him that putting it down as a reactor is common practice and his colleagues do it. In the end, John says that he’ll look at the milking records to see if they are worth getting rid of or not and then speak to him about it. Now, a week later, Robert says that John never got back to him and they were put through as IRs. Even so, Robert is still worried about what he should have done, and what his colleagues would have done. Although he’s worked in the practice for 2 years, he’s still not sure what they do: ‘some of these things just don’t get talked about. You hear stories, but…’. A couple of weeks later though, they do get talked about. At the end of quiet Tuesday, the vets in the practice are comparing what they got up to during the day. The conversation turns to the accuracy of the skin test and the problem of not finding the disease at post-mortem despite a positive test. ‘The thing is though’, says Henry, ‘I once pushed five through that were just IRs but at slaughter were full of disease’. Fiona tells a similar story of finding disease in a cow slaughtered by accident – it wasn’t even an IR. This prompts Robert to tell his story of the IR at John’s farm and not knowing what to do about it. The conversation drifts and people start to leave, but as Robert packs her bag, Steve, the senior partner says to him, ‘in all seriousness, we do push things through – when it looks like it or if its an IR by a millimetre or so’.

This account also reveals that transforming the protocol has much to do with the organisation of relationships between farmers and vets as defined by the bTB testing regulations. In the UK, bTB testing is contracted out to private veterinary practices so it is common for vets to regulate the customers own cattle. The impact of this relationship is particularly acute in relation to the veterinary career pathway. The career of a vet rises from an assistant to a partner. Assistant vets are usually given the most basic jobs such as bTB testing. A diet of bTB testing can soon become incredibly boring for younger vets but one way of escaping bTB testing is by becoming responsible for routine fertility visits. These take priority over bTB testing but attracting routine visits is not easy and can be dependent on a vets' performance at a bTB test. If a vet is looking to attract routine work, upsetting a farmer at the bTB test will do them no favours. For a farmer to request that you conduct his/her routine work, they must first see the vet as competent, trustworthy and not someone who stands out as different. The farm therefore acts as another site of learning for vets – both in terms of understanding the relationship between the protocol and cattle, but also the relationship between the farmer, vet and the protocol.

Farmers are aware of the different ways by which the protocol might be practiced, and their preferred version fits a particular rationality. Many farmers will see bTB testing as a bureaucratic obstacle – a 'licence to trade' – rather than an integral part of their farm management. Farmers may also question the protocol's ontology of bTB, when other methods – such as post-mortem – fail to confirm this version of disease. A good test for a farmer is therefore one that can be accomplished as quickly as possible so that they may attend to some 'proper' farm work. The interactions between farmers and vets before and during a test are important for they allow farmers to subtly suggest to the vet how he/she would like the test done. Questions such as 'how are you going to do this?' or 'are you going to clip them all?' represent requests to make the test as quick as possible by leaving out elements of the protocol. Thanks to the organisation of bTB testing and its relationship to the veterinary career trajectory, these requests to transform the protocol can be difficult to refuse. This will not always be the case: the relationship some farmers have with their animals may mean that conducting the test according to the protocol is required. Thus, by visiting different farms vets learn to tune the protocol to different circumstances, enacting different versions of bTB along the way.

Knowing the Test

The account above also tells us something else about the protocol. The protocol defines a universal standard for a TB test and the result of the test as definitive. However, this misrepresents the test. The accuracy of all medical tests is always subject to some degree of error: diagnosing disease is a balance of the relative danger of recording too many false positives or false negatives. In the case of the skin test, there is an extremely low likelihood of false positive results, but between a 33% - 20% chance of a false negative result: the test leaves behind a lot of infection (de la Rua-Domenech et al. 2006). This can be reduced by changing the interpretation of the test results: 'severe interpretation' helps to resolve the issue of false negatives but increases the chance of false positives. Moving to 'severe' also relies on finding bTB lesions at post-mortem, but this is not easy when lesions are often too small to find and the different priorities of abattoir workers means there is only time for a quick investigation. This means that enactments of bTB are often unclear, but the protocol serves to hide these uncertainties.

In practice, though, vets learn quickly that bTB is not singular but fluid: multiple enactments of bTB are possible. They see and share stories of the exceptions to the test's rules. At the same time, though, they are responsible for the management of the farm – their ongoing relationship with the farmer implicates them in the trajectory of the farm and its future. Managing this trajectory – or caring for the farm(er) – transforms the protocol and how the results of the test are interpreted. When judging the results, it is not simply what the test tells them that it is important, but a complex entanglement of relations taking in the history of disease on the farm, the type of cattle, their locations and the social characteristics of the farmer. For example:

'John is testing 200 cattle on a farm on which the farmer wants to sell up. But he's been down with TB for the last 2 years and he can't sell up until he's clear. He needs to have two clear tests before he can get the all clear and today is that second test. The dairy cows are tested first on the home farm. The test is being interpreted at standard, but if a reactor is found, then all the results will be re-interpreted at severe interpretation. John knows all the interpretation charts like the back of his hand and as each one comes through he automatically logs whether the cow will be an IR or reactor at both standard and severe. All the cows are clear, but towards the end one walks in and turns out to be an IR on severe, but only just by 1mm. The rest of the cows are clear, and John heads off to a separate group of steers. But here he finds a reactor – there's no getting away from it, the bovine reaction is huge. This means the sale of the farm is off. Perhaps. The group of cattle with the reactor had been separated from the main dairy cows for several months – they could be treated as a separate epidemiological unit. In that case, the dairy cows can be interpreted on standard and they are clear to be sold. John thinks about the farm: is there really a problem there? If there was, he would have seen more lumps, there would have been something else to see. But there wasn't, nothing at all. And an IR by 1mm on severe interpretation, when it would have been clear on standard – does that really mean it has TB? So what to do? John decides to change the measurements for the severe IR making it clear. A practical judgement, based on a veterinary assessment of the likelihood of disease, but connected to the social circumstances of the farmer'.

Knowing the test means being aware of the all the uncertainties, the implications of the test for farmers and their cattle, and being able to make an informed judgement of the likelihood of disease – a kind of 'situated epidemiology'. Rather than unthinking automatons, knowing the test invokes a caring relationship, one for the farmer and the cattle. In this relationship, universalities do not apply, there are always other things to think about, other things to take into account. Care is situated in immediate localised relations and the ability to make these judgements is what distinguishes veterinary care from the veterinary identify defined by the protocol. Making these judgements is part of what it means to be a vet.

These relationships mean several things for the protocol. First, it means that bTB is indefinite. Results can be changed either way: they may be downgraded or upgraded – IRs become reactors and vice-versa – to suit contingencies. Reflecting these fluid versions of bTB, new classifications of disease are developed. One of these is a cow that is 'nearly a reactor' – one whose readings are a millimetre away from classifying her as a reactor, but for the moment she is an IR. Vets will make a note of these 'near reactors' and depending on the results of other cattle may adjust them accordingly. If there are many reactors on the farm, there is clearly a problem of disease and it is better that the 'near reactors' are reclassified as 'real reactors' and removed as soon as possible. Second, the protocol is transformed when reactors are found. When reactors or near reactors are found, the protocol develops new lines of enquiry. Instead of a linear trajectory, it becomes recursive. New skin measurements may be taken to double check the measurements taken on the first day; lumps may be measured again and again, and individual results compared to those of the herd as a whole. This process of re-running through the protocol again and again is required to ensure that the cow and the farmer receive a fair chance. But equally, it recognises that the results of the skin test are not simple, but require serious (re)consideration.

Professional Cultures: Patching Things Up

As stated previously, the TB testing protocol enacts a particular identity for the vet: they are rational, logical and capable of following a sequence of events. In doing so, the protocol posits not only that there is a right way of testing, but there is also only one way of testing. Moreover, the protocol assumes that the test can actually be achieved and that it will be achieved in a kind of ideal environment without any challenges. The assumption that there are right ways of doing veterinary work and that veterinary work occurs in ideal conditions is anathema to vets, whether in relation to TB or other veterinary work. There are two distinct elements to the culture of veterinary practice: the first of 'making do'; and the second of perpetual uncertainty. Consider the following scenario:

'Its 5pm and there's an emergency to treat a cow with a cut leg. John says he'll go because he's on call later. By the time we arrive at the farm its pitch black. The injured cow is in a shed without any light. The farmer brings a torch, but its not very powerful. His son decides instead to drive the tractor into the shed and use the headlights instead. There is a flap of skin hanging down from the cows left leg. John needs to give the cow some sedative to get it off its feet before he can do anything. This is complicated. The farmer and his son fetch a large metal gate from outside and use some baler cord to tie it to a fence in the shed. They manage to persuade the cow to walk over to the fence where they trap her by squeezing the gate up against her. John puts some sedative into the cow, but its not enough. Judging the right amount is achieved by estimating the weight of the cow, but giving too much can cause more problems. John decides to give the cow some more, this time in the neck. The cow goes down and John is able to clean the cut with some hot water. The farmer fetches a large breeze block covered with a plastic feed bag to raise the cow's leg. The flap of skin is hanging down. The following day, Fiona tells me that she never bothers to stitch those up as it never works. But today, John decides to try. The stitches go in and a dressing applied to try and prevent any infection. But this is futile – John

says none of this is sterile, there will be infection, but the priority is to get the cow back on her feet and deal with any infection later. As soon as the dressing is on, the cow jumps back up on her feet, the sedative having worn off. A perfect dose suggests the farmer. John knows different'.

The culture of making do is writ large in this account. The use of the tractor, the gates, baler cord and breeze block to permit the operation to proceed are common transformations of objects used to ensure the progress of veterinary work. For bTB testing, the story is similar. Gates and crushes are lashed together with baler cord to ensure their stability. Tractors are parked precariously to ensure that cattle do not escape. People stand in gaps to ensure animals can be herded from sheds to the testing site. Agricultural space is constantly remade by transforming the identities of farmyard subjects and objects. These heterogeneous materials quite literally hold bTB tests together and in doing so define veterinary expertise.

To conduct veterinary work, therefore, vets must also change: they must learn to be affected and adapt to the conditions, work with imperfections and learn to re-engineer space however haphazardly. The ideal world of the protocol is not one which is readily encountered and transforms the practice of the protocol. In these suboptimal conditions, attempting to measure lumps highlights the ambiguity of measurement: squeezing the callipers too hard can skew the result, but so will attempting to measure a cow that will not stand still in a crush. Attempting to 'make do' in these situations means giving the benefit of the doubt to cattle: for the sake of the protocol, vets are often unprepared to condemn a cow in these circumstances.

This account also highlights the perpetual uncertainty that vets work with. Administering drugs to cattle is not a precise science, but one based on estimation and guesswork. Equally, there never seems to be a right answer to the treatment of cattle. For example, the account above shows the difference between Fiona and John's approach to dealing with a cut leg. The bTB testing protocol therefore expects vets to be extracted from this world of uncertainty which demands constant vigilance and adaption to one in which these qualities are not required. The apparent universality of the TB protocol neither fits with the day to day experiences of veterinary work, nor does it fit with the practical style of veterinary working that vets need to develop to survive. Within the heterogeneous relations that configure this working environment, the local universality of the protocol is inevitable.

Conclusion: Transforming Protocols – Localising Disease

Protocols enact versions of disease and forms of veterinary expertise. Disease is singular, identifiable, standardised. Enacting bTB simply requires following rules. Yet in practice, for the bTB protocol to work, it is necessary to transform the protocol and all that goes with it. The transformation of the protocol occurs in the crystallisation of relations between vets, other vets, farmers, cattle, machinery, bodily parts, sensations and even the weather. Local universality emerges from these heterogeneous relations in which vets tasked with bTB testing find themselves within. These relations configure a working environment to create and normalise new ways of enacting bTB. Storytelling and informally developing new rules cannot be divorced from the relationships vets have with farmers, cattle, technologies, career structures and a sense of professional identity. Within these relations, transforming the protocol from one that is universal to one that is locally universal is inevitable to make it work across space, albeit in a more or less kind of way.

In transforming the protocol different versions of bovine TB are enacted. A new geography of disease is created in which its identity varies to degrees between different spatial contexts. To be clear, these multiple versions of disease do not depend on wildly different diagnostic techniques but on subtle variations in technique developed in relation to cows, vets, farmers and other actors. The protocol is never completely jettisoned, just as situated practice never completely takes over: the balance between them is constantly shifting at different farms and for different animals. These shifts in veterinary practice do not progress along some-sort of timeline, as might be the case for other animal diseases (see Law and Mol 2011). Rather, there is constant unevenness and flow between the veterinary practices that are being enacted: the care involved in attending to situated contexts can never be disentangled fully from the uniform practices inscribed by the protocol. Enacting animal disease requires this movement: it is what local universality entails.

The fluidity to the spaces of animal disease also challenges the nature of veterinary expertise. Whilst the aim of this paper has been to reveal the situated expertise of the veterinarian, it would be a mistake to view this as belonging solely to vets. Rather the forms of expertise used to enact disease are themselves emergent from the objects and subjects within the relations that constitute disease. This means that expertise belongs no more to vets than it does farmers or cattle. However, the role of these other actors does raise the question of whether the uniformity of the protocol has been replaced by another form of expertise that itself is universal, or that it is too dependent on a limited group of powerful actors which is the reason why protocols are not implemented. Similarly, studies of human medicine focus on the importance of understanding norms of professional identity in order to change behaviour in line with formalised systems of medical care (Dixon-Woods et al. 2009; Waring 2009). It may be dangerous to under-estimate the role of powerful actors (such as farmers or Practice partners) and instead champion the heroic situated knowledge of the vet. Certainly, the practices of situated knowledge are not exclusive to the logic of care. Careful practices may be practiced in uncareful ways: sometimes they may be simply copied not learned, or worse compelled, and marginalise other possibilities. Equally, vets may choose to enact the protocol as a form of control over some farmers. The role of situated knowledge in managing animal health may itself need more careful consideration. At the same time though, it is also the case that these relations establish what is possible and what works (Timmermans and Berg 1997). Thus, it is ironic that whilst the protocol seeks to act from a distance, it is the very distance – both ideologically and institutionally – between Government and practicing vets that contributes to and legitimises the transformation of the protocol.

For policy makers concerned with the regulation of animal health, these conclusions pose something of a dilemma. In seeking to preserve the universal authority of the protocol, they must either ignore the significance of local universality or re-organise the conditions in which bTB testing occurs. Ignoring the significance of local universality does not necessarily reassert beliefs in the authority of standardised science. As Waterton (2002) shows, where attempts to classify nature are imprecise, ignoring their ambiguity can help to ensure wider policy objectives are achieved. Similarly, it has been suggested that an agriculture that is less vulnerable is one that is less dependent on aspirations to uniformity across space (Hinchliffe 2007; Law 2006). For bTB, such an approach may have appeal: without the flexibility of local universality, vets have suggested that the task of bTB testing might be rejected altogether. This would have wider implications for the geography of animal health services in the UK.

But accommodating flexibility within a protocol is not something that everyone agrees with, not least because of the legal function of the protocol in securing international trade. State vets and policy makers from Animal Health and the UK Governments have increasingly sought to tighten the way vets use the protocol. Training has been revised and firm guidance issued to those already testing to remind them to test according to the rules (Animal Health 2008). The accounts in this paper show that this approach misunderstands the issues. Issuing advice to enforce the protocol seeks to preserve the scientific and standardised nature of veterinary expertise. Whilst this might suit an audit and management style of governing, it does not reflect the reality of veterinary practice. A reliance on protocols risks the bureaucratisation of a profession which is never less than a situated practice, seeking a practical balance to a range of competing rationalities.

Enforcing the protocol may only heighten tensions and reduce trust between the Government and the veterinary profession. This is because risk management practices are shaped by the relationships into which actors are organised. Simply telling vets to behave differently ignores the importance of these relations, the reasons why they exist and the tacit expertise that fall outside the apparently easy steps of the protocol. Most of all, however, reaffirming the protocol assumes that vets are individually responsible when it comes to implementing the protocol and cognitively deficient if they fail to follow it. Such a view denies the significance of the organisation of disease management which, as this paper suggests, plays a significant role in transforming the bTB protocol. An alternative approach is to therefore look for new forms of organisation in which bTB testing can take place. This may require, for example, the creation of new institutions in which flexibility and indeterminacy is valued rather than ignored (see for example Eden 2008; Hinchliffe 2001). Without addressing the way bTB testing is organised, it should be no surprise to find that balancing the demands of existing customers and their farms in a chaotic environment transforms the protocol. If the transformations of the protocol achieved by vets in practice are truly detrimental to the surveillance of bTB – and it is not clear whether or not they are – then it is to the organisation of disease surveillance that Governments should attend.

[1] The fieldwork for this paper was conducted in two private veterinary practices over a period of four months. I also spent a further 2 months within an Animal Health divisional office. During this time I workshadowed vets and participated in their work as they conducted bTB tests and other veterinary duties. Observations were recorded in a field diary at the end of every day. Reflections on these activities can be found in Enticott (2011). Informal and formal interviews were also undertaken with vets in each of these practices. Interviews with 19 practicing, academic and policy vets provided helped to ground-truth data and explore issues raised in the fieldwork. The vignettes for this paper were drawn from data from the two private practices and interview data. For the purposes of anonymity, locations are not revealed and names are pseudonyms.

[2] Animal Health is an executive agency of the Department for Environment, Food and Rural Affairs responsible for the implementation of animal health policy in the United Kingdom.

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