Mapping microbial stories: Creative microbial aesthetic and cross-disciplinary intervention in understanding nurses’ infection prevention practices

Emma Roe | Charlotte Veal | Paul Hurley

School of Geography and Environmental Sciences, Faculty of Environmental and Life Sciences, University of Southampton, Southampton, UK

Correspondence
Emma Roe
Email: e.j.roe@soton.ac.uk

Funding information
Engineering and Physical Sciences Research Council, Grant/Award Number: EP/M027260/1

Consistent implementation of hand-washing within the hospital environment remains a challenge in infection prevention (IP) procedures. IP is one of a number of measures to tackle antimicrobial resistance (AMR). A cross-disciplinary team was assembled to experiment with different ways of visualising the microbial. The paper details a comparative experimental design where nurses \( n = 2 \) performed a series of routine care procedures in a mock-ward setting where traces of coloured ultra-violet glow-powders had been purposely placed, first with routine hand-washing and second without routine hand-washing. The results presented as a series of photos, video-clips, ethnographic observations and nurse interviews explore nurse-microbial relations and the potential for affective and embodied encounters with microbial worlds to generate new insight in IP. We argue for creating unfamiliar aesthetics that engage the sensate as an intervention in established IP education. The aesthetic rendered invisible microbes visible through techno-artistic practice. The performance term “devising” was used to analyse the cross-disciplinary methodological process. Finally, we consider the potential for nurses to act as microbial citizens as they extend their care for the human to entail the need to care for the microbial, perhaps not to kill but to relocate the risky pathogen, as part of a commitment to multispecies living in a world with AMR.

KEYWORDS
aesthetics, cross-disciplinary, embodied knowledges, experiment, hand hygiene, infection prevention, microbial worlds, practice

1 | INTRODUCTION

Contact-transfer of pathogenic organisms on the hand is an important means by which patients acquire infection in hospitals, and numerous tests have been used to evaluate the efficacy of procedures designed to interrupt spread by this route. (Marbles & Towers, 1979, p. 237)

Marbles and Towers (1979) and others from subsequent eras (Gould, 1991; Kelsall et al., 2006) have evidenced the importance of hand-washing within infection prevention (IP) procedures. Ensuring consistent implementation of hand-
washing within the hospital environment, however, remains a substantial challenge. Is it a failure of education, of care, forgetfulness, or an ongoing risk when events overcome routine? In 1998, Courtenay argued that the literature examining the teaching and learning of infection control principles is limited in scope with a number of factors working against effective performance of hand-washing. More recent research in healthcare recognises the multifaceted structural challenges to changing the hygiene behaviours of healthcare professionals, and visitors, in order to reduce infection risks to patients (Pittet et al., 2000; Whitby et al., 2007). By contrast, Prieto (2016, p. 5) writes:

Principles of infection prevention are notoriously difficult for healthcare workers to grasp and to apply consistently … the interpretation of these principles within policies and practice guidelines is not always clear or presented in ways to enable ready application to practice.

Whether education or a structural failing, the risks of infection spread when hand-washing does not take place have been proven (Kelsall et al., 2006).

Situated within the large cross-disciplinary research investment (see Medical Research Council, 2018) to address the global challenge of antimicrobial resistance (AMR), this research project focuses on IP practice. IP is one of a number of measures being used to reduce antibiotic usage (Allegranzi & Pittet, 2009; Moody et al., 2012), and there is consensus that tackling AMR caused by high levels of antibiotics in the environment (O’Neill, 2015), in part, requires hygiene practices to be urgently addressed. A cleaner environment, where humans (and animals) contract disease less often, would lead to a reduction in antibiotic use. If the need for antimicrobial use can be reduced, then the opportunity for a resistant strain to adapt through gene transfer in the microbial landscape following repeated exposure to antimicrobials is also reduced (Costelloe et al., 2010).

This paper reports on the research activities of an interdisciplinary team of scholars. The authors bring their different methodological and disciplinary perspectives to this challenge that spanned social, health, biological, and engineering sciences, and the humanities. We ask, first, can we make new non-medico-scientific knowledges about the IP practice of hand-washing in the hospital environment? And second, how can different disciplinary knowledges, aesthetics, and technologies collaborate and unite to bring original approaches to the study of shared objects of research interest?

Human geographers have argued for the need to study lay embodied knowledges of biological (including microbial) organisms (Greenhough & Roe, 2006). Additionally, Kirksey and Helmreich (2010) have introduced the concept of multispecies ethnography to study the hosts of organisms of varying scales whose lives and deaths are linked to human social worlds. Spanning health and cultural geographies, a literature has developed studying nursing practices. Andrews and Moon describe the value of a qualitative geographical approach to understanding the micro-scale spatial features of disease, in terms of social interactions “among patients,” “between staff and patients” (2005, p. 58), and how “the complex features of health settings may facilitate or contain the disease in terms of work cultures (norms, rituals), organisational and management cultures” (2005, pp. 58–59). Thus, while the term micro-scale geographies is referred to, it is not a material geography of mobile, microbial lives they described. Our work extends this literature by attending to the agency and performative qualities of the non-human within the micro-scale spatiality of disease played out among bodies of staff, patients, and work cultures, and also the affective presence of lively microbial organisms.

Following Law (2004), research methodology makes the world we study, rather than solely describing the world we are in. In a wet-skills lab – where water, pseudo-pathogens as ultraviolet (UV) powders, mannequin bodies, hospital equipment, and (training) nurses can entangle and make mess – creativity and interdisciplinarity came together. We illustrate how nurses “know” the microbial, and reflect on what a multispecies ethical commitment to care, not only for the human but also the non-human microbial world, would offer. In this way, the findings develop the field of human microbiome research by adding to debates about knowledge deficit or structural reasons which explain how hand-washing can fail to happen. We also discuss how, by working creatively with “pedagogic materials,” commonly used to teach IP globally, we can make unfamiliar non-cognitive embodied experiences through presenting novel visualisations that usefully intervene in the routine.

2 | LITERATURE REVIEW

2.1 | Microbial life

The last three decades have seen cultural geographers begin to unsettle the “human” within human geography, putting “the onus on ‘livingness’ as a modality of connection between bodies (including human bodies) and (geo-physical) worlds”
(Whatmore, 2006, p. 603). The scaling of these enquiries has nearly always been bigger than the microbe. This special issue of *Geo* is evidence of a shift in scalar focus towards the microbe and how it works as an agent to shape human encounters with “other” humans, animals, and soils because of the activity of microbial life (see Bastian et al., 2017; Haraway, 2003; Hird, 2010). Such research follows Hird’s assertion that microorganisms, whether bacteria, archaea, fungi, protozoa, algae, or viruses, are *actants* that, time after time, form “symbiotic companions with life on earth” (2009, p. 133). Microbes are not just on us but actively “make us up,” participating in our digestion and eating, and supporting fermentation processes (Ingram, 2011). What unites these studies is that each seeks to advance thinking on more-than-human worlds and public understanding of them. However, humanistic agendas still dominate “expert” approaches to studying human engagement with microbial worlds, with emphasis being given to the threat they pose to human physical and financial well-being; for example, the IP paradigm in the health sciences. This study supported cross-disciplinary knowledge exchange in terms of letting cultural geographers into the workspaces of nursing, and introducing health scientists to cultural geographical insights on the social life of pathogenic microbes and how they shape the embodied, tacit, and everyday geographies of labouring nursing bodies.

Shared health risks at the human, non-human and environmental interface (see Haraway, 2003; Hinchliffe, 2015) have seen cultural geographers engage with the geographies of health and disease by examining non-humans in the form of harmful and benign organisms, disease vectors, host species, and antibiotics and antibacterials. Cliff et al. (2009, p. 221) argue that antimicrobial agents have formed the “cornerstone of therapeutic responses to infectious diseases for almost 70 years” (see Blaser, 2014). At the heart of this public health approach is an emphasis on antimicrobial worlds where fewer microbes equate with healthier places (Lorimer, 2017), thus fostering an untargeted destruction of microbial life. Interestingly, the rise of AMR has prompted a shift towards *displacing* harmful microbes rather than complete eradication. This could be through encouraging the growth of good microbes or the spatial displacement of harmful microbes in water solution through cleaning practices. Significantly, cultural geographies of microbes are valuable empirically and methodologically by asking different questions about human–microbial–technology life relations.

### 2.2 Nursing and infection prevention

Interest is growing in the intersection between nursing, healthcare work, and spacetimes (Andrews, 2003; Liaschenko, 2001), alongside calls for nursing pedagogy to engage productively with knowledges developed outside of its disciplinary borders (Holmes & Gastaldo, 2004; Holmes et al., 2007). For Andrews and Evans (2008), the post-1990s geographies of nursing literature has offered insight into the socio-spatial complexity, diversity, and day-to-day operation of working life in healthcare. Gavin Andrews (2003) argues that the emergence of this interdisciplinary field can be accredited to two principal structural changes over recent times. The first is a shift in healthcare provisions (i.e., community-based care), and the second relates to changes in nursing roles and responsibilities (prioritising physical closeness). Sandelowski describes nurse presence as a “felt perception on the part of embodied and vulnerable patients that they are cared for” (2002, p. 64). This emphasis on embodied empathy signals critical awareness of the emotional dimensions of labour (Hochschild, 1983), but also simultaneously, a move away from viewing body work as “dirty work” to the “cleaner” work of technology (i.e., viewing the patient in terms of their condition).

In their daily work, healthcare staff take measures to protect themselves and patients from infection through the use of personal protective equipment and hand hygiene (Beam et al., 2011; cf. Lapum et al., 2012 on the liminal space between technology and nursing practice; also see Sandelowski, 1999). IP practices actively work to tackle the risks associated with sick human bodies sharing space and sharing professional attendant practitioners; in other words, nurses, doctors, and other healthcare staff. However, it is known that the application of IP principles in practice remains inconsistent (d’Alessandro, 2015). Studies show that healthcare workers’ adherence to recommended hand hygiene procedures is highly variable (between 5% and 89%), and varies by health profession (World Health Organization, 2009, p. 66; see Pittet et al., 2000). d’Alessandro (2015) examines the discrepancy between practices and standards of medical hygiene in preventing hospital-acquired infections in Niger. The author argues on the one hand how a lack of disposable materials and equipment makes it impossible to implement appropriate infection-prevention practices that rely on specific tools (sterile gloves, disinfectant, soap, compresses). Yet on the other, D’Alessandro suggests that the “shared geographies” and the absence of formal spatial segmentation for different activities contributes to the spread of (anti)microbial life: “the cleaners put the mop to dry on the railing. Later … a nurse took out … injectable drugs, syringes, needle, etc…. put them on the railing, and started to prepare an injection” (2015, p. 66). This fieldwork emphasises the need to understand the movement of pathogenic agents as the output of a complex interplay between objects and human touch. How might creative methodologies create new
knowledges with non-human microbial life as part of a reinvigorated move to appreciate what is at stake? What could be our ethical responsibilities to multispecies living in the spaces of nursing work?

2.3 | Creative methodologies

A body of work that supports research with non-human life is by feminist science scholars like Haraway (2008, 2016) and Barad (2012). They have encouraged greater attention to how we understand the practices we study, as well as to those we perform ourselves as researchers in the course of doing research, as interactive change-bringing interventions in the material world (see Roe & Greenhough, 2014). Both interventions encourage us to respond to the choreography of intra-action between materialities and practices – particularly pertinent for research involving non-humans – with care for what worlds we make together. Non-representational theories (Thrift, 2008) and growing interest in performance and practice (Butler, 1990) are also useful for thinking through “the composition and working of assemblages through which health arises and is performed” (Andrews, 2018, p. xii; see Andrews, 2017). The philosophy of nursing literature itself has not been immune to methodological and interpretative frameworks that draw on post-structuralism, phenomenology, affective and performative theories and methodologies (see, for example, Ducey, 2007, 2010; Holmes et al., 2010; Lapum, 2008). Likewise, these theories have contributed to cultural geographical scholarship around nursing that prompts consideration of our haptic-sensory encounters with the socio-materiality of the non-human, although the focus of this work has been on agentive technologies rather than agentive biological matter. Not only can the visceral materiality and agency of our networked configurations with the non-human world be considered, but also the imaginative, emotional, and aesthetic geographies that shape our responses to managing, mitigating, living with, and avoiding contact with the non-human world; whether stag beetles (Lorimer, 2007), bees and butterflies (Bingham, 2006), or slugs (Ginn, 2014).

Microbes, touch, and various visualisation techniques have featured in creative and participatory methodologies within cultural geography and beyond. Macduff et al. (2014) have explored how healthcare workers and patient representatives conceptualise pathogens through different forms of risk-identification activities, and accounted for the envisioned geographies of pathogens (as “monster,” “creature,” “nasty”). Not dissimilarly, in their “Kitchen Safari,” Hodgetts and Lorimer adopted an “upstream citizen science” approach to “provide important insights into peoples’ hygiene practices and understandings in a world characterized by both ‘good’ and ‘bad’ microbes” (2017, p. 27). In an example of activism meets performance, Mukherjee (2016) illustrates how food installation art might animate concerns over environmental toxicity by front-staging non-humans, and local resident’s forced intimacy with them. Interest in microbial worlds has equally spread to art practitioners. Artist Mellisa Fisher (2013, 2017) and microbiologists Clements and Betts have, for example, collaborated on a series of living sculptures, including “Microbial Me” and “Microbial Michael.” These works, created from human body casts made from agar and cultivating bacteria from the artist’s own skin, make visible the growth of bacteria, partially through the use of UV light.

2.4 | Interdisciplinary methodologies

There is a strong case for working creatively to address adherence to IP guidelines and its connection to the social life of microbes that generate what Dame Sally Davies (2017) from Public Health England calls the “wicked issue” of AMR. However, there is also a need to foster interdisciplinary ways of working on this issue. We follow Hinchliffe et al. in asserting that emerging diseases, and their subsequent resistance, are “more than a matter of microbes alone” (2016, p. xiii). To create an understanding of the relations between microbes, hosts, and their social and physical environments, and a cultural geography of microbial life, we need to develop new methodological approaches and connections beyond the constraints of disciplinary borders. In the context of human and non-human worlds, Buller has described interdisciplinarity as an “(inter)active practice of convergence involving the relational construction of distinct areas and objects of interaction, intermediacy and translation that lie beyond disciplinary frontiers” (2008, p. 396). What Buller offers our approach is a framework for thinking about interdisciplinarity as creative and as a process, which is, by its very nature “explorative rather than definitive” (402).

There is a long history of interdisciplinarity between science and art, with organisations such as Arts Catalyst (2016) and Wellcome Trust (2018) producing and funding creative outputs in association with scientific research. Likewise, much cultural geographical scholarship, particularly post non-representational “theory,” has been characterised by engaging with creative methodologies (McCormack, 2013; Veal, 2016) and lively collaborations with a host of art practitioners and practices (Dixon, 2009; Hawkins, 2013) as a way of accessing the precognitive, embodied, sensual knowledge that “makes us
human.” Yet what seems missing is how cultural geographical knowledge might advance interdisciplinary studies within the health sciences.

3 | METHODOLOGY: THE STAGING OF THE EXPERIMENT

*Mapping Microbes* (2016) was an interdisciplinary pilot project involving two engineers, two academic nurses, a microbiologist, a performance artist, and two cultural geographers. The project was funded through an EPSRC Bridging the Gap Research Grant; a scheme committed to the notion that “a multidisciplinary approach is needed to tackle these challenges and make a step change in addressing antimicrobial resistance” (2014, p. 2). *Mapping Microbes* focused specifically on theme three; “examining behaviour within and beyond the healthcare setting” (2014, p. 2). As cultural geographers, we reflect on our experiences of academic boundary crossing, and our encounters with the falling away of presumed disciplinary-specific methodological toolkits. Indeed, while our ontological vantage points differed across disciplinary training and learning, whether understanding microbes as isolated, mobile vectors for disease spread, or “situated matters” as disease (Hinchliffe et al., 2016), we collectively came together to examine how rendering the non-human sense-able might shape knowledge practices.

The methodological process was anchored at the outset by the following questions:

- To what extent might we demonstrate the agency of non-humans?
- Can creative methods contribute to understanding the perception of risk associated with transmission models of contagion?
- How can we creatively map the movements of simulated microbes through the routine touch practices of nurses?
- Can creative methods produce pedagogic materials for healthcare workers?

Two stages of the research process are discussed in this paper as findings: the process of designing the experiment itself which we report on as findings; and the “data outputs” from running the pilot experiment with two registered nurses as photos, video-clips, ethnographic observations, and qualitative interview extracts with the nurses.

Due to health, ethical, and safety reasons, we were not able to conduct our research in a “live” hospital ward with real patients or to use actual pathogens. Therefore, we turned our focus to working with pedagogic materials in a wet-skills lab – a training environment for practicing nursing labour – and to explore it as a site in which our experiments could be trialled and tested (see Soffer, 2016). The research apparatus included pedagogic materials from a wet-skills lab: three plastic mannequins; three coloured UV sensitive Glo-Germ powders (used on their own and suspended in glycerine as a gel) that are invisible under natural light. These pseudo-substances (UV powder), used internationally in hand hygiene education in hospitals (Biswal et al., 2014; Vanyolos et al., 2015) and schools (Randle et al., 2013; Snow et al., 2008; Witt & Spencer, 2004), were literally brushed and scattered in various sites as pretend pathogens. We recruited two registered nurses, one with specific training in IP, to participate in our experiment. Unbeknown to the registered nurses, the pseudo-substances were moved around during routine hospital tasks, and then made visible when the room was illuminated by UV lighting. Such materials are frequently used to illustrate poor hand-washing techniques (Wiles et al., 2015) by providing healthcare workers with instant visual evidence of areas of “missed hand-hygiene” (Lehotsky et al., 2015, p. 83). In our research, we extended the use of these gels from not only hands but also patient bodies, equipment, protective clothing, bed linen etc.

With no live patients or dangerous pathogens, this allowed the investigative team to be creative, which was more akin to artist Luke Jerram (2018), who sculpts pathogenic microbes from glass than forms of BioArt employing live cells and tissues (Catts & Zurr, 2006; Dixon, 2009). These common UV substances have received little attention from artists. Pedagogic materials and clinical equipment were supplemented with creative apparatus – specialised UV lights, a camera, and tripod. We experimented with ways of making the microbial realm sensible, and to map human–non-human mobilities. Never entirely certain that our methodology might succeed, health scientists and cultural geographers constructed and staged a pilot experiment by using nursing, UV powders, and mannequin improvisation (Figure 1). To test the significance of hand-washing, the clinical tasks were carried out on the UV powder doused mannequins, both with and without regular handwashing from the nurses. The actions of the nurses were filmed live using the ward's CCTV and UV photos taken after each task. See Video S1\(^1\) – Bed change without gloves.
We pretend that our three patients have three different infectious conditions. Our ‘patients’ – Mr Blue, Green and Red – and associated props (sheets, bed rails, catheter) are then doused with three differently coloured UV powders that are pseudo-pathogens purposely chosen by our nursing colleagues; meticillin-resistant *Staphylococcus aureus* (MRSA), *Clostridium difficile* (*C. diff*), and *Escherichia coli* (*E. coli*). Corresponding with these conditions, a series of routine nursing practices were identified as potential causes of microbial transmission: changing bed sheets, emptying a catheter, facilitating use of a bedpan, and conducting observations. Two registered nurses in costume (scrubs) are called onto set, task sheets in hand, and asked to complete four routine nursing tasks, first without and then with recommended hand hygiene guidelines (gloves, hand washing, antimicrobial gels). (Veal, 17 May 2016)

There were obvious challenges to mapping microbiomes through the use of pseudo-substances. We were never studying the actual agency of mobile pathogens, but decoys located on bodies and equipment through existing microbiological knowledge of how our three pathogens behave. Nor were we studying nurse–patient interactions around microbial wellbeing in real life. In fact, the nurses clearly knew they were handling mannequins and pseudo-substances. In this world of pretence, the practices from the laboratory and the theatre stage (not the surgical theatre), to experiment and to improvise, overlapped. With improvisation, our scientific experiment became a performance, and our laboratory a theatre for performing and spectating on microbial worlds. Here we use the term experiment to describe the twice-repeated tasks we asked the nurses to perform, once using hand hygiene and once not using hand hygiene. The experimental process involved refining a solution that stuck to surfaces of metal, cotton, plastic, and glass, along the continuum between UV gel through to powder form. Some team members experimented with different ways of tracking repetitive movement using overhead CCTV cameras (installed for examining nursing training) and facial recognition software programs recoded (with limited success) for hands touching surfaces. The term improvisation refers to what the interdisciplinary experimenters enacted as they explored new ways of studying the non-human microbe. The artist Hurley improvised with aesthetic techniques of photographing simulated pathogens, and the engineering researchers explained the possibility of using UV lights and different optical filters that would make our UV powders light up.
Veal improvised with ways of notating haptic encounters within her ethnography that documented the mundane, practiced, haptic geographies of our nurses. The term performance describes the product of the improvisatory and experimental labours; the non-human microbes performing an aesthetic, all colourfully aglow, to narrate a human–non-human story.

Following the experiment (the performance by nurses of a series of routine tasks), semi-structured interviews were conducted with both nurses to discuss their experience in the experiment.

4 | NURSING PRACTICES: RESPONDING TO HUMAN–NON-HUMAN CONFIGURATION

4.1 | Dirt and caring

An embodied response to “feeling” dirty (“it's the psychological thing because you know you need to wash your hands”; Nurse One) was identified by both nurses as driving hand hygiene practice. For both nurses, the context of the experiment gave a heightened experience of feeling dirty to that common in their work on hospital wards. By dirt, or “matter out of place” (Douglas, 1966), Nurse One referred to “flaky skin” and mobile “bodily fluids” (see Dixon & Straughan, 2010; Longhurst, 2001), to which one could add sickness, vomit, and sweat – all potential vectors of pathogens, even in trace quantities. While labelled by the nurses as psychological, we interpret this thinking as emergent in response to being a vulnerable, porous body; through physically reaching out and onto (touching) or being materially affected by another body, it can render either body at risk. The agent of risk here, of course, is not the human body, but the microbial ones that accompany it. Similarly, for the nurses, handling patients with specific medical conditions resulted in a corporeal sense of the non-human as leakage, as repugnant, as contaminating, as soilage, and as seepage. Following this logic, when performing their tasks without hand hygiene measures, both nurses therefore recounted their anxieties of being proximal to potentially harmful (albeit simulated) pathogens. Nurse One, while in conversation about Mr Blue’s documented skin condition, discussed the uncomfortable mobility of human-microbial matter.

You have patients who have excessive skin loss, so they have quite flaky skin because they are either dehydrated or have various skin conditions and you can see … and feel sort of the skin on your hands. So that would make me go and wash my hands.

Interestingly, Nurse One recognised that it was “controversial” to mention greater or lesser amounts of human-microbial matter shed from bodies. When discussing Mr Red, suffering from C. diff, Nurse Two also identified microbes’ risky materiality, and a sense of potential vulnerability from contaminating microorganisms hosted in sickness and diarrhoea:
You are much more aware of where your hands are. I am more aware, for example if I touch the handrail … I would definitely notice that … I would think to myself, oh sugar, he's got this condition, I've touched the handrail, I am going to need to remember to scrub a bit more.

4.2 | Making clean as care

Whether it is changing bed sheets, conducting observations, emptying catheters or bedpans, or administering intravenous medication, nurses touch or are touched, and consequently “making clean” is the closure of an activity. This “making clean” of themselves, equipment, or patient’s body may be acknowledged consciously or disappear from memory under the guise of routine, habit, or mundane daily *iterations* with microbial life. Part of the challenge of this act of making clean – alongside other creative “making” acts from making beds to making patients comfortable – is that one works with bodies whose imagined borders are permeable and leak “stuff,” dirtying surrounding environments. Furthermore, the practices and places that surround the very *materiality* of the stuff that leaks, including sickness and diarrhoea, accelerates the imaginative threat posed, both in time and, crucially, space. In light of significant medical and public knowledge of the cross-contamination risks of *E. coli* and *C. diff*, Nurse Two explained:

Definitely with the patient who we put on a commode. Even though it was a simulation, at the end of it, you just think to yourself, I've just touched the commode … I've wiped them. I need to go and wash my hands. (Figure 2; see also Video S2 – Bedpan with gloves)

Yet rather than suggesting that some conditions deterred tacit encounters, both nurses identified how patients with severe symptoms, including diarrhoea, would induce higher levels of nursing concern, which “instinctive[ly]” leads to greater acts of touch: “[I would] just feel their forehead. Just make sure they haven't got a raised temperature” (Nurse Two). Bodily

**FIGURE 2** Bedpan.
fluids like sweat are read in particular ways, in certain contexts, to tell a story of a body exposed, threatened by microorganisms whether as a consequence of infection, hormone, temperature, or humidity levels.

Alongside bodies, and the fluids and materials that leak and seep from them, the wider hospital landscape, including handrails, curtains, blood pressure cuff, and task sheets (Figure 3) were imagined by our nurses as potential sites or agents supporting cross-species contamination. As Nurse Two recounts, potential contamination was not only a story of his hands, but also:

The story of the equipment I am using. So for example, I know that this cuff it's going to be on this patient (Mr Blue), plus that patient (Mr Red), plus that patient (Mr Green). It's touching them and that's still a touch story. (Video S3 – Observations with no gloves)

This reflection suggests our simulated pathogens enhanced attention to the nurses’ movement of objects, like the task sheet, from one patient to another. The ability of microbes to reside in everyday nursing objects was made all the more apparent by our pseudo-substance’s materiality:

I definitely thought more about my handover sheet, I'm not going to lie about that, because obviously I could feel the grains [UV powders]. Every time I was touching it, I was thinking to myself … if I could not feel these grains, I would probably be touching it more. (Nurse Two)

4.3 | Enhancing senses of microbes

Our efforts to contextualise the performative and practiced characteristics of simulated microbes thus led to a critical engagement with the senses and illustrates the possibilities for technology to support, rather than hinder, caring practices
Our nurses express disgust as fingers touch the cold slimy powders spread on Mr Blue’s bed-rail. They laugh uncomfortably, not knowing what they have touched, and not wanting to touch again. Each examines the grainy qualities of the substance between their fingertips, but invisible to their eyes. Quickly, however, their focus returns to the task at hand, and they adopt their perfunctory practice of changing bed sheets with efficiency. A sense of curiosity about the stories their hands might tell nevertheless increases. (Veal, 17 May 2016)

Inadvertently, this moment offered a sense of how a heightened tactile experience of invisible agents could play out as education tool, as opposed to the common emphasis on the visual realm. One of the challenges of exploring AMR/IP relations is its nature as microscopic, and yet within nursing practice microscopes are never used. However, the microscopic worlds that lay beyond the known (visible/tactile) frontiers of human materialities (sick, urine, diarrhoea, dry skin) are “making worlds” (Salazar, 2017) of IP that shape nursing practices day-in-day-out. Collectively, these examples illustrate various geographies of microorganisms at play in nursing practice on a ward; they can become repulsive to look at, uncomfortable to touch, but equally, of little concern as the care priority requires reaching through the microbial “film” to touch a body that needs care. Microbes are awkward, but necessary, companions to be around because context situates how they become known (Hinchliffe et al., 2016). The status of microbial flora on the hospital ward shifts, depending on whether bodies with particular vulnerabilities to certain bacteria are near. Or, threats can be ignored when caring trumps IP, until the task is completed. Care and clean, care and clean, care and clean.

4.4 Creative jamboree of nurses, microbes, and researchers

Experimenting with, and encountering the non-human realm, equally provoked enquiries into the transdisciplinary team’s own practice. Here we conceptualise our research practices as an explorative style of researching and thinking about non-human materialism, as grainy and slimy, sticky, and moist substances. In comparison to their textbook teachings – concerned with the communication of microbiology and clinical routines – here microbes occupied the realms of presence as living subjects with vitality; they existed within three-dimensional space as shared configurators of the laboratory:

(Ducey, 2010). For our two registered nurses rehearsing the experiment without gloves, the microbes took on a performative materialism, as grainy and slimy, sticky, and moist substances. In comparison to their textbook teachings – concerned with the communication of microbiology and clinical routines – here microbes occupied the realms of presence as living subjects with vitality; they existed within three-dimensional space as shared configurators of the laboratory:

Our roles as researchers thus morphed in the research phase, as we played at being nurses (cf. nurses playing as patients; Soffer, 2016). Supported by our colleagues in nursing and microbiology, we experimented in creating an environment for resistant genes to generate and thus practices of IP should focus more upon the spatial displacement of “risky” bacterial organisms and not ultimate destruction. This point emphasises the significance of participatory research with more-than-human worlds. It also insists preventing infection by nurses may require the need to embed care for microbial lives alongside care for human lives.

At its most simplistic, our creative encounters with microbiome were staged. Prior to the “research phase,” our experiments were repeated, rehearsed, reworked, and iterated to make them “perform.” Our roles as researchers thus morphed in the pre-experimental phase as we played at being nurses (cf. nurses playing as patients; Soffer, 2016). Supported by our colleagues in nursing and microbiology, we experimented in learning how to make hospital beds and empty catheters (Figure 4), and practiced with the camera to achieve effective angles and lighting. Alongside our engineering counterparts we held coloured light filters, wheeled professional UV lights into position, and repeatedly sought to “excite” our powders in our garages, studios, offices, and laboratories. So too, during the “final performance,” our nursing activities were staged. Like a game of musical chairs, we called “action” and “cut,” collecting “evidence” at intervals of our (and our nurses’) choosing. We learnt more and more about the positionality – what knowledges mattered and why – of our interdisciplinary colleagues as we were requested to perform and improvise different roles, handle different technologies and materials, and were required to find a shared language so we could communicate beyond our disciplinary specialisms.
Our practice in transdisciplinarity was thus often conceptualised, to follow Buller (2008), as “explorations” in failure. For those of us interested in creating, improvising, experimenting, and devising, there is important space to provide a critical conceptualisation of failure (see Veal and Hawkins, forthcoming) or perhaps rather as Thomas A. Edison quotes, “I have not failed. I’ve just found 10,000 ways that won't work.” More so, in the world of performance, failure is integral to the creative process (O’Gorman & Werry, 2012). To exemplify, we became frustrated when our gels would not light up, when our gloves could not be distinguished by the facial recognition software programs re-coded for hands, the poor quality of our overhead surveillance cameras, and when our powders would not stick during haptic encounters. Yet those practical failures invigorated conversations and promoted the exchange of shared experiences and knowledge. Presented with elements that would not work led to new methodologies being presented, equipment being refashioned, new powder-glycerine substances concocted, and nursing stations reshaped. In such contexts, working out what works and what does not, and even what it means “to work” was integral to our experimental doings. This is not only significant in thinking about the very practical nature of transdisciplinary, but also the conception of risk-taking activities as improvisations in learning and doing.

5 | ENHANCING THE MULTISPECIES EXPERIENCE

5.1 | Unfamiliar aesthetics of the microbial

In this section, we consider what work microbial worlds produced through experimentations in light, captured in images, can add to the debates that surround IP practices. We ask, how can we creatively map the movements of simulated microbes through the routine touch practices of nurses? And, can the political-aesthetics surrounding IP shift away from an untargeted elimination of microbial life and towards fostering care for multispecies living in microbiotic worlds through an emphasis on displacement instead? In our considerations, we draw on Dixon’s work on how the political-aesthetics of the non-human have been presented through BioArt:

FIGURE 4 Researchers become nurses: changing bed sheets to apply UV powders.
The ‘matter’ of BioArt is of concern to a wide range of geographers, physical as well as human, insofar as it is the product of artists and scientists working together to engage public interest in the vital scientific, political and ethical issues of our day, making visible the policies, practices, artefacts and lifeforms that emerge from a technoscientific biology, certainly, but also environmental degradation and climate change. (2009, p. 423)

Hand-washing, UV light and glow powders is not the typical context for BioArt. It tends to focus on biotechnologies, for example bodily tissue storage, rather than public and professional education to support habitual hand-washing. However, here we were in a wet-skills lab, albeit with pseudo-“wet-ware” of pathogens and human bodies, but with the biological and technological fused into the pedagogic materials: UV light, UV-sensitive powder, and human hands/bodies entangled. This is an arena where the biological and the artist can work together to make visible different hygiene practices. Uniquely, this produced microbial worlds through experimenting with different spectrums of light rather than scale or “scopic regimes,” by employing the revealing qualities of UV. Here we follow Bastian et al., who building on Law (2004), argue that “methods don’t just describe worlds, but make worlds. That is they make some things more visible and others more difficult to take into account” (2017, p. 2). These fieldnotes explain the photographic performances we engaged in:

Over 200 long exposure, large aperture (1/10s, f3.5) photographs mapped the vital materiality of the two hour scene spatially, rendering visible microbial worlds. Later, a linear account of simulated non-human encounters with nurses, and their progression in time – whether on hands, gloves, beds, stethoscope, bedpans, or catheters – are digitised in an interactive timeline. (Veal, 15 June 2016)

Images like those below, we argue, gave a new apprehension of the microbial to our nurses. We go on to explore the politico-aesthetic of world-making around IP traditions that the production of our aesthetic artefacts sought to intervene in. One form of intervention is their use in a short film entitled These are the hands (Turp & Hurley, 2017) (see Video S4), which recognises how practices of visualising contribute to the production of geographical worlds (Crang, 1997). Building upon cultural geographers’ interest in touch and tacit knowledge (Paterson & Dodge, 2012), and intimate and affective spaces of the micro (Dixon & Jones, 2015), we argue that rather than approaching the body as isolated (molecular life as either “out there” or “in me”), we emphasise pathways via the vector of touch. Through touch the orifices of the body – mouth, wounds, urethra – become vulnerable to microbial others.

5.2 Staging what becomes visible and invisible

“Bad bugs” in the world have been given visibility in cartoon form on countless occasions. One recent addition to this canon is “Meet the Microbes” (Osborne & Smith, 2014), with anthropomorphic characters like “Steph Le Coccus.” In contrast, we let the simulated microbes perform visual stories (see DeSilvey, 2007) of potential pathogenic mobility between patients, objects, medical equipment, and clothing, disrupting their common “absent–presence” under normal working conditions, and thus anthropocentric “ways of seeing” (Berger, 1972). We think here about the value of producing alternative knowledges about medico-scientific landscapes, including the cultural and ethical complexities of nursing in response to the more-than-human, and making worlds that configure the micro-scale and molar-scale in various ways. Both nurses reflected upon how seeing simulated pathogens under UV lights – on their bodies, clothes, and nursing equipment – confirmed the necessities of hand hygiene practices, and reinforced their IP training. Like Macdonald and MacDuff (2018) and Macdonald et al. (2017), the Mapping Microbes team created visualisations of non-humans (as simulated pathogen) by fusing aesthetics, nursing care, and scientific knowledge (see Macduff et al., 2014); yet the politico-aesthetic aimed to engage microbial citizenship practices, drawing on Haraway’s (2016) manifesto for multispecies living. Findings from interviews indicate we had some success. Nurse Two explained, “I appreciated what hand washing does […] but you do not appreciate how much it has transferred, and then seeing it there it was like, oh goodness.” Discussing the images, Nurse One also noted that it was a “fantastic way of showing that if I went from bed one to bed four that movement would occur.”

Through images, evocative of starscapes, TV forensics, or acid house raves, the aesthetic encounters with the non-human world estranged nurses from the mundanity of clinical objects and tasks in hand. The multiplicity of coloured powders illustrated in the images (Figure 5) demonstrated both opportunities for cross-contamination, but were also informative in envisaging microbes as negotiating their own complex positionalities within dynamic multispecies communities, habitats, and microbial “cities” (Watnick & Kolter, 2000). In this respect, it advocated for the agency of microbes as mobile, labouring, performing actants, active in the shaping of dynamic shared landscapes. This was not only via optical
techniques of depth of field and zoom, but also changes of light, employed in the creation of affective atmospheres. As Edensor notes, “illumination uniquely blurs the boundaries between affects generated by representational and nonrepresentational qualities” (2012, p. 1112). This blurring also suggests a consideration of magic at work in the creative aesthetic we were using:

Magic works by transforming the visible (or what is available to the spectators’ senses), playing on an economy of visibility/invisibility. Magic does not only or mostly obscure; magic works as much through what is shown as what is hidden. (Rolfe, 2014, p. 1605)

The transformative process of the UV and camera image operated across scalar distances to create a stage and audience where a political aesthetic worked differently than would a microscope. Sontag (1977) conceives of photographing as an act of appropriation, cultivated as a result of positioning oneself in relation to the world. By contrast, our photographs gave opportunities to explore contrived visual relationships that purposefully brought attention to non-human agency; as present, active, material, and mobile. Furthermore, using photography to emphasise mobility, and by experimenting aesthetically and technologically with relative size, the non-human gained visible recognition. Hence, these surrogate micro-beings gained currency as requiring “care-ful” relationships (see Ginn et al., 2014); care for and care of. The implication was both to “scale up” the micro beyond the microbial realm (to that readable by the human eye), but equally, to splice through the restrictive binaries of visible/invisible, micro/macro. As such, the camera became a technology for making simulated things visual and magical – and imbuing them with the real (“yukky”) agency of that which they substituted.

5.3 | Creative aesthetics and knowledge intervention

Yet more than this, the creative outputs also combined practices and narratives of the nurses with data from artistic, rather than scientific, perspectives of the simulated microbes. Can creative methods produce pedagogic materials for healthcare
workers? The effect was to produce a creative knowledge intervention that tells a story of infection (between patients, nurses, objects; Figures 6 and 7), in a way that would not have been possible from a single-perspective microbiological or IP study. Thus, following Auslander’s (2006) work in performance studies, the images produced were both *documentary* and *theatrical*. That is to say, they recorded an event (with the potential for its re-enactment) as well as manipulated the aesthetic to create a new artefact. This aestheticisation of medico-scientific knowledge, through artistic (though not abstract) imagery of a real experiment in real space, created an affective/emotive understanding of microbial infection and its agency; that is, we argue, invaluable in the fight against AMR.

Was the political-aesthetic of these images cultivating a new sensibility to the microbial; a microbial citizenship? Following Roe and Buser (2016) who argue participatory performance art can engage people with the politics of ecologies, through staging embodied intra-actions with non-humans, here the political aesthetic provokes wonder at what microbial citizenship could be. As health policies tackle the challenge of AMR, political aesthetics work to give new visions on the microbial, generated through embodied activities. Such visions may prepare people for the complexity that surrounds caring for the microbiome as entangled with the health of bodies of any species bigger than the micro. This complexity of caring was illustrated by Nurse Two when discussing the nasal cannula:

> Out of instinct, I would move it out of the way, even though I know there may be [microbes]. There should be a better way to do it. I would do it because […] it's still on the patient, although maybe I should be more *careful*.

The making visible of microbial actants within the experiment led nurses and researchers towards a “thinking with” (Haraway, 2016) rather than a thinking *about* non-humans in *geographies* of infection. This was not only in terms of the simulated pathogenic materialities, but also the non-human technologies such as the commode, blood pressure cuff, and task sheet. Interpreting visualisations of microbial life through ecological thinking prompted us, as cultural geographers, to approach care from multiple directions and to engage productively in debates around pro- and pre-biotics and the microbiota.
6 | CONCLUSION

Given the ongoing challenges of ensuring healthcare workers grasp IP, and apply them in practice (Prieto, 2016), and growing interest in how people and things are co-configured in practice (Soffer, 2016), the move our research makes to create an embodied experience that offers a different way to communicate the principles through the medium of the sensate have been proven as effective in this pilot study ($n = 2$). In answer to our first research question, yes, we can make new non-medico-scientific knowledges about the IP practice of hand-washing in the hospital environment. The experience presented simulated pathogenic microbes in colour or as “yucky” to the touch to perform on a stage that interrupted the familiar aesthetic of the ward environment – contrasting the light with the dark, the palette of healthcare with the palette of neon glowing, the feel of metal, skin, fabric with a sticky coating. The world we created was an unfamiliar aesthetic, but not in terms of the architecture of patient and healthcare equipment and the request to get on with highly practiced care routines. Further research to scale this study up would arguably be beneficial to take the findings further and consider how they can be embedded into IP training approaches.

The study illustrated the value of creative methodological play within microbial worlds to foster potential new ways of knowing, ways of imagining the vital, liveliness of a diversity of microbes whether their capacity to move or the environments that support their life. Importantly we learnt audiences may not need the specific microbiological detail, but instead can still respond generally to actors (UV powders) performing for risky pathogenic matter; this abstraction is powerful when carefully staged to key into other aspects of the familiar. For example, the photographs employed the aesthetic, the emotive, and the performative to re-orientate the gaze and centre-stage the microbe. The assemblage of images rendered these hidden geographies present, producing visible haptic spacetime scores in which mobility is seen, not from human-centric detached, aerial, or microscopic gazes, but alongside and in conjunction with human practice. Incorporating elements of the aesthetic into the production of the experiment presented a fundamentally novel and multifaceted piecing together, and imagistic testimonial, of human–non-human happenings within the familiarity of the ward.
In responding to calls for nursing scholarship to move beyond hegemonic paradigms and stagnant methodologies to understand the complexity and messiness of human social life (Holmes & Gastaldo, 2004; Holmes et al., 2007), we argue, in answer to our second research question, yes, cross-disciplinary approaches are vital to generate new knowledges of the microbial because one discipline alone could never have achieved the synthesis of approaches, technologies, and expertise that is evident in the making of the experiment and its findings. Using the performance language of “devising” enabled us to think of interdisciplinarity as framework, theories, methods, and language originating from collaborative, often improvisatory, sharings and doings. The value of the concept of “devising” is thus in foregrounding a process of sharing knowledge, improvising with that knowledge, failing in some of the steps, and having another go with new insight. Our study is a rich illustration of one such cross-disciplinary process tackling working on microbial life. Our experience accords with Borgdorff’s characterisation of transdisciplinary research as involving “a partial inter-penetration of practice, theory, and method, in response to research questions arising from highly specific, local contexts” (2012, p. 92); in our case the local challenge of hand-washing to prevent infection spread by nurses. And, there is much potential in bringing physical, biological, social, health, and creative arts altogether to collectively tackle the microbial world because of the pertinence of the various expertises to address a world too often invisible yet world-shaping in how it is known.

Finally, our work sought to respond to the challenge, identified by Haraway (2016), to bear witness to how practices affect the lives of multiple species and to give scrutiny to where and for whom the ethical import to care lies. Nurses became interesting subjects to witness because of the iterative care practice of making clean worlds often made dirty by the microbial. Further work is needed to understand how microbial citizenship could foster understanding for valuing the lives of microbes alive, but perhaps moved away from the vulnerable in water solution, rather than killed by cleaning with antimicrobials agents. Our project has offered a different political-aesthetic of microbial worlds, to the cartoon depictions of feared/imagined bugs, which does give visibility to multispecies living with microbes. This is a start.

ACKNOWLEDGEMENTS

We are very grateful for the opportunity to develop this cross-disciplinary research project with University of Southampton colleagues Dr Jacqui Prieto and Professor Lisette Schoonhoven (nursing), Dr Sandra Wilks (microbiology), Professor Xunli Zhang and Dr Robert Zmijan (bioengineering). Thank you also to the two nurse practitioners who outside of their working hours spent time taking part in our experiment. Much appreciation also to Professor Tim Leighton for his enthusiastic support and guidance as principal investigator of EPSRC award EP/M027260/1 Network for Anti-Microbial Research Action (NAMRA) that funded this research. Thank you also to the members of Network for Anti-Microbial Research and Infection Prevention (NAMRIP) at the University of Southampton and beyond. We greatly appreciated the helpful comments from the anonymous reviewers and editors that have enhanced the paper significantly.

ORCID

Emma Roe [https://orcid.org/0000-0003-4674-2133]
Charlotte Veal [https://orcid.org/0000-0001-9272-4396]
Paul Hurley [https://orcid.org/0000-0002-8964-5774]

NOTES

1 It is not possible to see the UV powder/gel traces in videos 1, 2, and 3 because they were filmed under normal room lighting, not UV light.
2 Two statements about the pattern of spread of pseudo-pathogens are given in this film. However detailed discussion of the methodology and findings of the patterns of spread of pseudo-pathogens are beyond the scope of this paper. However, briefly, the quantitative measure of “200 touches in four minutes during a bed change” that feature in Video S4: In Our Hands film is based on an extension of the original project to experiment with quantifying touch using the novel software capabilities of MAX MSP with a touch-screen interface (engineered by Matthew Olden of The Mighty Jungulator) to analyse the filmed record of the clinical tasks. The quantitative statement “Routine hand hygiene reduced cross-contamination by up to 100%” is a statement that uses the non-medico-scientific language of the nurses who witnessed with their naked eyes the reduction in cross-contamination. This lay-reading of “up to 100%” was supported by photos taken under UV lighting when hand hygiene was used (n = 20) and when hand hygiene was not used (n = 25). No microbiological testing was carried out.
REFERENCES

d'Alessandro, E. (2015). Human activities and microbial geographies. An anthropological approach to the risk of infections in West African hospitals. *Social Science and Medicine, 136*, 64–72. https://doi.org/10.1016/j.socscimed.2015.05.016

Allegranzi, B., & Pittet, D. (2009). Role of hand hygiene in healthcare-associated infection prevention. *Journal of Hospital Infection, 73*, 305–315. https://doi.org/10.1016/j.jhin.2009.04.019

Andrews, G. (2003). Locating a geography of nursing: Space, place and the progress of geographical thought. *Nursing Philosophy, 4*, 231–248. https://doi.org/10.1046/j.1466-769X.2003.00140.x

Andrews, G. (2017). Geographical thinking in nursing inquiry, part two: Performance, possibility, and non-representational theory. *Nursing Philosophy, 18*, e12137. https://doi.org/10.1111/nup.12137

Andrews, G. (2018). *Non-representation theory and health: The health in life in space-time revealing*. London, UK: Routledge.

Andrews, G., & Evans, J. (2008). Understanding the reproduction of health care: Towards geographies in health care work. *Progress in Human Geography, 32*, 759–780. https://doi.org/10.1177/0309132508089826

Andrews, G., & Moon, G. (2005). Space, place, and the evidence base: Part I—An introduction to health geography. *Worldviews on Evidence-Based Nursing, 2*, 55–62. https://doi.org/10.1111/j.1741-6787.2005.00504.x

Arts Catalyst (2016). Retrieved from www.arts catalyst.org/content/about-arts-catalyst

Askins, K., & Pain, R. (2011). Contact zones: Participation, materiality, and the messiness of interaction. *Environment and Planning D: Society and Space, 29*, 803–821. https://doi.org/10.1068/d11109

Auslander, P. (2006). The performativity of performance documentation. *PAJ: A Journal of Performance and Art, 28*, 1–10. https://doi.org/10.1162/pajj.2006.28.3.1

Barad, K. (2012). On touching.—The inhuman that therefore I am. *Differences: A Journal of Feminist Cultural Studies, 23*, 206–223. https://doi.org/10.1215/10407391-1892943

Bastian, M., Jones, O., Moore, N., & Roe, E. (Eds.) (2017). *Participatory research in more-than-human worlds*. London, UK: Routledge.

Beam, E., Gibbs, S., Boulter, K., Beckerdite, M., & Smith, P. (2011). A method for evaluating health care workers personal protective equipment technique. *American Journal of Infection Control, 39*, 415–420. https://doi.org/10.1016/j.ajic.2010.07.009

Berger, J. (1972). *Ways of seeing* [Video]. Retrieved from www.youtube.com/watch?v=0pDE4VX_9Kk

Bingham, N. (2006). Bees, butterflies, and bacteria: Biotechnology and the politics of non-human friendship. *Environment and Planning A, 38*, 483–498. https://doi.org/10.1068/a38436

Biswal, M., Rajpoot, S., Dhaliwal, N., Appananavar, S., Taneja, N., & Gupta, A. (2014). Evaluation of the short-term and long-term effect of a short series of hand hygiene campaigns on improving adherence in a tertiary care hospital in India. *American Journal of Infection Control, 42*, 1009–1010. https://doi.org/10.1016/j.ajic.2014.05.025

Blaser, M. (2014). *Missing microbes: How killing bacteria creates modern plagues*. London, UK: One world.

Bolton, S. (2000). Who cares? Offering emotion work as a “gift” in the nursing labour process. *Journal of Advanced Nursing, 32*, 580–586. https://doi.org/10.1046/j.1365-2648.2000.01516.x

Borgdorff, H. (2012). The mode of knowledge production in artistic research. In S. Gehm, P. Husemann, & K. von Wilcke (Eds.), *Knowledge in motion: Perspectives of artistic and scientific research in dance* (pp. 73–80). London, UK: Transaction Publishers.

Buller, H. (2008). The lively process of interdisciplinarity. *Area, 41*, 395–403. https://doi.org/10.1111/j.1475-4762.2008.00856.x

Butler, J. (1990). *Gender trouble: Feminism and the subversion of identity*. Oxon, UK: Routledge.

Callard, F., & Fitzgerald, D. (2015). *Rethinking Interdisciplinarity across the social sciences and neurosciences*. London, UK: Palgrave Macmillan.

Campkin, B., & Cox, R. (Eds.) (2012). *Dirt: New geographies of cleanliness and contamination*. London, UK: IB Tauris.

Catts, O., & Zurr, I. (2006). The tissue culture and art project: The semi-living as agents of irony. In S. Broadhurst, & J. Mchon (Eds.), *Dirt: New geographies of cleanliness and contamination*. London, UK: IB Tauris.

Cliff, A., Smallman-Raynor, M., Haggett, P., Stroup, D., & Thacker, S. (2009). *Emergence and re-emergence. Infectious diseases: A geographical analysis*. Oxford, UK: Oxford University Press.

Costelloe, C., Metcalfe, C., Lovering, A., Mant, D., & Hay, A. (2010). Effect of antibiotic prescribing in primary care on antimicrobial resistance in individual patients: Systematic review and meta-analysis. *BMJ, 340*, 1–11. https://doi.org/10.1136/bmj.c2096

Crang, P. (1997). Picturing practices: Research through the tourist gaze. *Progress in Human Geography, 21*, 359–373. https://doi.org/10.1111/030913297669603510

Davies, S. (2017). Antimicrobial resistance: A cause for collaboration. Retrieved from www.gatescambridge.org/news/antimicrobial-resistance-cause-collaboration

DeSilvey, C. (2007). Art and archive: Memory-work on a Montana homestead. *Journal of Historical Geography, 33*, 878–900. https://doi.org/10.1016/j.jhg.2006.10.020

Dixon, D. (2009). Creating the semi-living: On politics, aesthetics and the more-than-human. *Transactions of the Institute of British Geographers, 34*, 411–425. https://doi.org/10.1111/j.1475-5661.2009.00354.x

Dixon, D., & Jones, J. (2015). The tactile topologies of Contagion. *Transactions of the Institute of British Geographers, 40*, 223–234. https://doi.org/10.1111/tran.12071

Dixon, D., & Straughan, E. (2010). Geographies of touch/touched by geography. *Geography Compass, 4*, 449–459. https://doi.org/10.1111/j.1749-8198.2009.00299.x

Douglas, M. (1966). *Purity and danger: An analysis of concepts of pollution and taboo*. London, UK: Routledge and Kegan Paul.
Ducey, A. (2007). More than a job: Meaning, affect, and training health care workers. In P. Clough, & J. Halley (Eds.), *The affective turn: Theorizing the social* (pp. 187–208). Durham, NC: Duke University Press.

Ducey, A. (2010). Technologies of caring labour from objects to affect. In E. Borris (Ed.), *Intimate labors: Cultures, technologies, and the politics of care* (pp. 18–32). Stanford, CA: Stanford University Press.

Edensor, T. (2012). Illuminated atmospheres: Anticipating and reproducing the flow of affective experience in Blackpool. *Environment and Planning D: Society and Space*, 30, 1103–1122. https://doi.org/10.1068/d12211

EPSRC (2014). Bridging the gaps between the engineering and physical sciences and antimicrobial resistance. Retrieved from www.epsrc.ac.uk/files/funding/calls/2014/btgamrcall/

Fisher, M. (2013). *Microbial me*. Retrieved from www.mellissafisher.com/microbial-me

Fisher, M. (2017). Current work. Retrieved from www.mellissafisher.com/current-work-1

Ginn, F. (2014). Sticky lives: Slugs, detachment and more-than-human ethics in the garden. *Transactions of the Institute of British Geographers*, 39, 532–544. https://doi.org/10.1111/tran.12043

Ginn, F., Beisel, U., & Barua, M. (2014). Flourishing with awkward creatures: Togetherness, vulnerability, killing. *Environmental Humanities*, 4, 113–123. https://doi.org/10.1215/22011919-3614953

Gould, D. (1991). Nurses. *Nursing Philosophy*, 13, 129–136. https://doi.org/10.1111/j.1466-769X.1991.tb01353.x

Greenhough, B., & Roe, E. (2006). Towards a geography of bodily biotechnologies. *Environment and Planning A*, 38, 416–422. https://doi.org/10.1068/a38514

Guthman, J., & Mansfield, B. (2013). The implications of environmental epigenetics: A new direction for geographic inquiry on health, space, and nature-society relations. *Progress in Human Geography*, 37, 486–504. https://doi.org/10.1177/0309132512463258

Haraway, D. (2003). *The companion species manifesto: Dogs, people, and significant otherness*. Chicago, IL: Prickly Paradigm Press.

Haraway, D. (2008). When species meet. Minneapolis, MN: University of Minnesota Press.

Haraway, D. (2016). *Staying with the trouble: Making kin in the Chthulucene*. Durham, NC: Duke University Press.

Hawkins, H. (2013). For creative geographies: Geography, visual arts and the making of worlds. New York, NY: Routledge.

Henderson, A. (2001). Emotional labor and nursing: An under-appreciated aspect of caring work. *Nursing Inquiry*, 8, 130–138. https://doi.org/10.1046/j.1440-1800.2001.00097.x

Hinchliffe, S. (2015). More than one world, more than one health: Re-configuring interspecies health. *Social Science & Medicine*, 129, 28–35. https://doi.org/10.1016/j.soscimed.2014.07.007

Hinchliffe, S., Bingham, N., Allen, J., & Carter, S. (2016). *Pathological lives: Disease, space and biopolitics*. Chichester, UK: John Wiley & Sons.

Hird, M. (2009). *The origins of sociable life: Evolution after science studies*. Basingstoke, UK: Palgrave Macmillan.

Hird, M. (2010). Meeting with the microcosmos. *Environment and Planning D: Society and Space*, 28, 36–39. https://doi.org/10.1068/d2706wsc

Hochschild, A. R. (1983). *The managed heart: Commercialization of human feeling*. Berkeley, CA: University of California Press.

Hodge, T., & Lorimer, J. (2017). Good germs, bad germs, citizen science and microbiology. *The Biochemist: Magazine of the Biochemical Society*, 39, 35–37.

Holmes, D., & Gastaldo, D. (2004). Rhizomatic thought in nursing: An alternative path for the development of the discipline. *Nursing Philosophy*, 5, 258–267. https://doi.org/10.1111/j.1466-769X.2004.00184.x

Holmes, D., Gastaldo, D., & Perron, A. (2007). Paranoid investments in nursing: A schizoanalysis of the evidence-based discourse. *Nursing Philosophy*, 8, 85–91. https://doi.org/10.1111/j.1466-769X.2007.00302.x

Holmes, D., O’Byrne, P., & Murray, S. J. (2010). Faceless sex: Glory holes and sexual assemblages. *Nursing Philosophy*, 11, 250–259. https://doi.org/10.1111/j.1466-769X.2010.00452.x

Ingram, M. (2011). Fermentation, rot, and other human-microbial performances. In M. Goldman, P. Nadasdy, & M. Turner (Eds.), *Knowing nature: Conversations at the intersection of political ecology and science studies* (pp. 99–112). Chicago, IL: University of Chicago Press.

Jerram, L. (2018). About glass microbiology. Retrieved from www.lukejerram.com/glass/about

Kelsall, N., Griggs, R., Bowker, K., & Bannister, G. (2006). Should finger rings be removed prior to scrubbing for theatre? *Journal of Hospital Infection*, 62, 450–452. https://doi.org/10.1016/j.jhin.2005.09.002

Kirksey, S., & Helmreich, S. (2010). The emergence of multispecies ethnography. *Cultural Anthropology*, 25, 545–576. https://doi.org/10.1111/j.1548-1630.2010.01069.x

Lapum, J. (2008). The performative manifestation of a research identity: Storying the journey through poetry. *Forum Qualitative Sozialforschung/Forum: Qualitative Social Research*, 9, 1–33. https://doi.org/10.17169/fqs-9.2.397

Lapum, J., Fredericks, S., Beanlands, H., McCay, E., Schwind, J., & Romanik, D. (2012). A cyborg ontology in health care: Traversing into the liminal space between technology and person-centred practice. *Nursing Philosophy*, 13, 276–288. https://doi.org/10.1111/j.1466-769X.2012.00543.x

Law, J. (2004). *After method: Mess in social science research*. London, UK: Routledge.

Lehotsky, A., Sziágyi, I., Ferenci, T., Kovács, L., Pethes, R., Wéber, G., & Haidegger, T. (2015). Quantitative impact of direct, personal feedback on hand hygiene technique. *Journal of Hospital Infection*, 91, 81–84. https://doi.org/10.1016/j.jhin.2015.05.010

Litwack, J. (2001). Nursing work, housekeeping issues, and the moral geography of home care. In D. Weistub, S. Gauthier, D. Thomasma, & G. Tomossy (Eds.), *Aging: Caring for our elders* (pp. 123–137). Dordrecht, The Netherlands: Springer.

Longhurst, R. (2001). *Bodies: Exploring fluid boundaries*. London, UK: Routledge.
Veal, C. (2016). A choreographic notebook: Methodological developments in qualitative geographical research. *Cultural Geographies*, 23, 221–245. https://doi.org/10.1177/1474474015571944

Watnick, P., & Kolter, R. (2000). Biofilm, city of microbes. *Journal of Bacteriology*, 182, 2675–2679. https://doi.org/10.1128/JB.182.10.2675-2679.2000

Wellcome Trust (2018). *The arts*. Retrieved from wellcome.ac.uk/what-we-do/our-work/arts

Whatmore, S. (2006). Materialist returns: Practising cultural geographies in and for a more-than-human world. *Cultural Geographies*, 13, 600–610. https://doi.org/10.1191/147447406cgj377oa

Whitby, M., Pessoa-Silva, C., McLaws, M., Allegranzi, B., Sax, H., Larson, E., Seto, W., Donaldson, L., & Pittet, D. (2007). Behavioural considerations for hand hygiene practices: The basic building blocks. *Journal of Hospital Infection*, 65, 1–8. https://doi.org/10.1016/j.jhin.2006.09.026

Wiles, L., Roberts, C., & Schmidt, K. (2015). Keep it clean: A visual approach to reinforce hand hygiene compliance in the emergency department. *Journal of Emergency Nursing*, 41, 119–124. https://doi.org/10.1016/j.jen.2014.11.012

Whitby, M., Pessoa-Silva, C., McLaws, M., Allegranzi, B., Sax, H., Larson, E., Seto, W., Donaldson, L., & Pittet, D. (2007). Behavioural considerations for hand hygiene practices: The basic building blocks. *Journal of Hospital Infection*, 65, 1–8. https://doi.org/10.1016/j.jhin.2006.09.026

World Health Organization (2009). *WHO guidelines on hand hygiene in health care: First global patient safety challenge clean care is safer care*. Retrieved from apps.who.int/iris/bitstream/10665/44102/1/9789241597906_eng.pdf

**SUPPORTING INFORMATION**

Additional supporting information may be found online in the Supporting Information section at the end of the article.

**Video S1.** Changing bedsheets with no gloves.

**Video S2.** Removing used bedpan with gloves.

**Video S3.** Observations without gloves.

**Video S4.** “In Our Hands” film.

**How to cite this article:** Roe E, Veal C, Hurley P. Mapping microbial stories: Creative microbial aesthetic and cross-disciplinary intervention in understanding nurses’ infection prevention practices. *Geo: Geography and Environment*. 2019;e00076. https://doi.org/10.1002/geo2.76