Knowing Pandemics: An Investigation into the Enactment of Pandemic Influenza Preparedness in Urban Environments

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Abstract

How does microbial emergence become a local area of medical, political, and technological intervention in cities such as London or Frankfurt? Through a multi-sited ethnography of urban health authorities, hospitals, blue light services, and epidemiologists, this article examines the achievement of pandemic order in times of crisis. Its specific focus is on pandemic influenza preparedness. By tracing the complex spatiotemporal, technological, and administrative dimensions required for the articulation of a local pandemic threat, this paper will look at how public health experts know about the arrival of an influenza pandemic, how sociotechnical networks are assembled in the decision-making process, and how single cases of illness are drawn into spaces of pandemic potential. Integrating concepts from science and technology studies and critical global health, the article highlights how disease emergence entails hard work and administrative, technological, political, and biomedical skills in order to be made present and tangible. In consequence, it will be argued that local pandemic preparedness does not result from a linear adaption of internationally circulating standards, but from rather precarious modes and modalities of ordering.

Keywords: influenza preparedness, emergency planning, global health

Introduction

This paper is about the enactment of influenza preparedness in the cities of London and Frankfurt. Specifically, it offers insights into how seemingly global microbial circulation processes are entangled with emerging practices of risk management and urban governance through complex sociotechnical networks, thereby initiating specific pandemic orderings that determine what can be seen, known, or said within the social context of emergency planning (see Hempel, 2011: 9).

To discuss how local spaces of pandemic potential emerge, the paper combines insights from critical global health scholarship and the literature on technologies of biosecurity, risk, and infectious disease surveillance. It employs the concepts of preparedness and enactment (see Mol, 2002). First, the preparedness: what does preparedness mean in a global health context? Second, the enactment: how are pandemics enacted?

Pandemics, by definition, are considered global events (Last, 2001: 179), believed to impact human health, and economic and political wellbeing on a global scale. They are problematised in the context of global health discourses. Anthropologist Andrew Lakoff (2010: 59) reminds us that "different projects of global health imply starkly different understandings of the most salient threats facing global populations, of the relevant groups whose health should be protected, and of the appropriate justification for health interventions that transgress national sovereignty". Thus, nowadays, the management of pandemic crises is believed to overwhelm the capacity of national public health systems. Current modes of global health security, as Lakoff (2010) argues, rely on compliance from national governments in establishing preparedness measures tailored to potentially catastrophic pandemic threats. However, pandemic preparedness is not only a high priority political rationale, it also assembles medical and security measures, providing a framework to be implemented in local, national, and international preparedness plans.

Pandemic preparedness is often described as a source of friction between the numerous voices, interests and policies in the area of global health (see Wallace, 2009): economic concerns arise around the disruption of financial flows, the imposition of travel bans, and the impact of factory farming on viral emergence. Political debates problematise different modes of knowledge production, big data, and biosecurity issues. Controversies develop surrounding the efficiency of pharmaceutical intervention. Among the many voices evolving in the area of global health, the World Health Organization (WHO) has certainly played a key role. Shortly after the emergence of SARS and highly pathogenic avian flu viruses in 2005, the WHO cautioned against the security threats posed by microbes with pandemic potential. In the World Health Report 2007, WHO Director-General Margaret Chan stated:

> These threats [of infectious disease emergence and antimicrobial resistances, MW] have become a much larger menace in a world characterized by high mobility, economic interdependence and electronic interconnectedness. Traditional defences at national borders cannot protect against the invasion of a disease or vector. […] Shocks to health reverberate as shocks to economies and business continuity in areas well beyond the affected site. Vulnerability is universal. (WHO, 2007: 2)

In a 2015 interview with Science magazine on the lessons learnt from the 2014 Ebola outbreak in West Africa, Chan reflects on international outbreak response measures:

> Countries that are affected by an outbreak should be transparent and report their diseases. Countries that are not directly affected should not impose trade or travel measures over and above what is recommended by WHO. This is part of the International Health Regulations [IHR], an international treaty with the good intention of building a collective defense system against a common threat. But the implementation of the IHR is very poor; there is a lot of disincentive. Why should I report? The minute I report, you impose a trade ban and travel ban on me. That is why we need to review the IHR and change them to provide incentive instead of disincentive. […] We can encourage countries by telling them: "We will help you out but not just to contain the outbreak." After the outbreak is done, we will do a gap analysis, together with the government, and bring in supporters, donors, to help them build a health system that is better capable of detecting an outbreak. (Science, 2015)

As vulnerability is portrayed as universal, pandemic preparedness has become a *global* enterprise. Nowadays, international global health experts agree that there is a need for international and transdisciplinary cooperation to successfully combat, contain, and monitor emerging pathogens. As determined by the IHR 2005 outbreak management has altered priorities, away from containment measures at entry points such as airports and seaports, towards rapid response at the source of an outbreak. Now, all countries are encouraged to meet a set of "core capacity requirements […] in order to detect, assess, notify and report the events covered by IHR" (WHO, 2013). Although the WHO has no legal means of ensuring compliance, the report assures that compliance is in countries' best interest as through the proper detection, assessment, notification, and reporting of outbreak events the country in question is supposed to be capable of containing the outbreak and reducing its disruptive impact (while this is also believed to maintain the country's "good standing in the eyes of the international community", WHO, 2007: XV)[1].

From a global health perspective, then, pandemic preparedness might be understood as a – necessary – response to microbial messiness[2]. Yet, on the other hand critics rightfully claim that microbial 'emergence' is neither a natural phenomenon, nor a mere consequence of a growing interconnectedness: pathogens do not suddenly 'emerge' somewhere, for example in the backyards of Southeast Asian poultry farmers. Rather disease emergence depends on enacting specific analytic and sociotechnical frameworks: classifications of emerging infectious diseases are contingent on certain conditions (Farmer, 1996; Grisotti and Ávila-Pires, 2010): to be classified as emergent, a pathogen needs to be linked to a specific disease (for example bird flu), to a vulnerable population (for example young children), to surveillance systems (for example the Global Influenza Surveillance and Response System), and to a territory (for example the UK). In order to fulfil their function as classificatory categories, categories need to be "discrete, measurable and definable" (Abeysinghe, 2013: 922; Bowker and Star, 1999). Also, emerging microbial agents depend on political and normative frameworks to be articulated, problematised and transformed into microbial risks that can be known, managed, calculated, or visualised (Collier and Lakoff, 2008: 9–12; Barker et al., 2013). As such, pandemics and politics are closely entangled, as a pandemic is "not an event out there, but a decision to be taken" (Guggenheim, 2014: 9). This article aims to contribute to this discussion by scrutinising how exactly these decisions are made in the face of microbial and scientific uncertainty, and how global health knowledge on emerging pathogens is enacted, contested, and circulated. Engagement with knowledge and uncertainty from an STS-informed perspective helps question the dichotomy between an object to be known (the pandemic) and the knowing subject (public health experts; see Mol, 2002). It also helps to de-naturalise the event-like character of a pandemic (see Guggenheim, 2014) and essentialist assumptions about disease emergence. In her critical account on the WHO alert phases, global health scholar Sudeepa Abeysinghe (2013) shows how the reality of the 2009 H1N1 pandemic failed to match the classificatory categories as employed by the WHO, stressing the discrepancies between the rarity, variability and flexibility of pandemics on the one hand, and the stability, risk-based and formalised nature of classifications on the other hand.

From a social science perspective, influenza preparedness is a modality of future-oriented emergency or resilience planning. Preparedness relies on actors, and it relies on the anticipation of risks. Following geographers Peter Adey and Ben Anderson (2012), preparedness can be understood as an apparatus of security, building on a series of devices, practices, discourses, technologies, and standards: "Preparedness does not obey a single logic of performance. Underpinning preparedness […] are rationalities and logics of security performed through techniques of risk management" (Adey and Anderson, 2012: 101). In a related notion, Anderson (2010) argues that anticipation does not seek to eliminate uncertainty, but to invoke a potential future. This future is subject to governance approaches. As such, the concept of preparedness is closely related to other concepts in the world of emergency planning: resilience, contingency planning, anticipatory action, and risk management. In her empirical work on influenza preparedness in Israel, anthropologist Limor Samimian-Darash (2013) argues that preparedness as a set of technologies is distinct from these other approaches in so far as it mobilises a *potential uncertainty* in which several possibilities might emerge simultaneously: "Potential uncertainty is like a question no answer can suppress or saturate. In this sense, potential uncertainty is not equivalent to the unknown future but is linked to the intermediate space between what has occurred and what is about to occur" (Samimian-Darash, 2013: 3). Here, preparedness relies on uncertainty to govern a future that cannot be cut down to calculable forms (see also Abeysinghe, 2014). Preparedness, seen from this perspective, is distinct from other scientific practices (such as risk management) that depend on the eradication of uncertainty in order to establish *facts* (Fleck, 1980).

As a political concept and rationale, preparedness has attracted much scholarly attention, and numerous publications have displayed its close relationship with biosecurity issues (Collier and Lakoff, 2008), addressed the politics inscribed into security technologies (Ellis, 2014) or analysed preparedness in connection with disaster management programmes in more general terms (Tironi et al., 2014). By combining historical accounts of previous pandemics with insights into experimental microbiological research, anthropologist Carlo Caduff (2015: 177) sketches how public health discourses cumulate in a pandemic prophecy, articulating a "total threat, affecting everyone". Geographical research has been particularly productive in stressing the tensions between "fixity and movement, territory and circulation, centralised control as well as redistributions of responsibilities" underlying current approaches of preparedness and precautionary action (Hinchliffe and Ward, 2014: 137; see also Donaldson, 2008; Enticott et al., 2012). Policy transfer studies have illustrated how political ideas wander into scientific contexts where they seem to offer 'technological' answers to specific problems (Walt et al., 2004), and they have questioned the assumption that health policies are integrated 'rationally' into decision-making processes, meaning to construct uniformities across time and space (Timmermans and Berg, 1997).

However, little is known about how global ideas of prevention and influenza preparedness are achieved and *practised* locally through networks consisting of a range of diverse actors – which brings us back to the second point made at the beginning of the article: enactments. Preparedness as a practice has a time and a place. It is something that people do. Working at the intersection of global health policies and the sociotechnical preparedness apparatus, I am particularly interested in this *doing* of preparedness, in the actors involved with it, and in the specific forms of cooperation and translation they are creating. This paper looks at how information is gathered, managed, circulated, and consumed. Consequently, other preparedness practices, such as the stockpiling of antivirals, or the mobilisation of economic resources, will receive less analytical attention.

As urban environments are commonly portrayed as being more prone to infectious disease outbreaks than other areas (due, among others, to high population density, global connectivity, and often poor sanitary conditions; see Alirol et al., 2011), they seem to be a good starting point for research on pandemic preparedness. The boundaries and 'borderlands' (Hinchliffe et al., 2012) of cities are often perceived as potentially fragile and in permanent need of maintenance, stressing cities' crucial role in responding to global health challenges. This article is about the enactment of pandemic influenza preparedness in London and Frankfurt. Being two of the most important international mobility hubs, these cities have implemented a thorough (though different) planning framework. Both accepted their assumed vulnerability as mobility hubs, important business locations, and tourist destinations. Both assemble a broad range of things, people, technologies, biological matter, and information to make their city resilient and prepared. Also, both cities are embedded in very different social structures and different political frameworks.

Through a multi-sited ethnography of urban health authorities, hospitals, emergency services, and epidemiologists in Frankfurt and London, this article examines how pandemic preparedness measures are enacted in these two urban environments. It looks at what Adey and Anderson (2012) call the *life* of an apparatus of security, so instead of arguing about the need for preparedness, or analysing its strategic goals, this article focuses on how to understand the sociomaterial contingencies of pandemic preparedness. Obviously, a pandemic does not merely happen – there is no single objective and reliable parameter that determines the arrival of a pandemic virus in geographically confined areas. Although the influenza virus engages in manifold relationships with other organisms, it is invisible to the human eye. Flu symptoms are similar to symptoms caused for example by pneumonia, a common cold, or other infections. The progress of the disease may differ from previous epidemics. Patients with flu-like symptoms do not undergo routinised virological screening. When taken together, *knowing* that a city is struck by pandemic flu constitutes a complex sociotechnical process. It can never be *pure* knowledge. If we do not presume pandemic influenza to be "an event out there" (Guggenheim, 2014: 9), and if we take seriously Theresa MacPhail's (2010: 59) postulation that "scientific authority persists not despite uncertainty, but *because* of it", the question as to how experts *know* about the arrival of flu becomes more pressing. With Annemarie Mol (2010) I believe that the term 'co-ordination' is helpful here

> … since it does not evoke a single, overarching and coherent order in which everything fits just fine and friction-free like the bits and pieces of a mosaic or the components of a watch. Instead, the term co-ordination suggests continuing effort. Tensions live on and gaps must be bridged, hence the need for 'co-ordination'. Coordinating efforts may take many forms. […] Even keeping potentially competing versions of reality (or modes of ordering, or logics) out of each others' way – by distributing them over different sites – may be glossed as a form of co-ordination. It helps, after all, to avoid confrontation and, along with that, chaos. (Mol, 2010: 264).

In this sense, microbial messiness has to be transformed into a pandemic order. What follows looks at how this order is achieved.

The paper will do so by considering, first, the spatiotemporal framework that translates microbial emergence into a pandemic. Against this backdrop, it will be discussed – in a second step – how individual cases of illness are fed into surveillance systems and thereby achieve visibility. Third and finally, the last subchapter deals with the question of how individual concerns result in the local raising of alarm. In short, how are we to understand the material contingencies of pandemic preparedness?

Methods

The article is based upon a four-year multi-sited ethnography of pandemic preparedness as it is practised in the cities of Frankfurt and London (from October 2011 to September 2015). The study design includes comparative elements, although it is not conceptualised as a comparison of two distinct settings along abstract and, presumably, universal categories. Comparability, however, is not an intrinsic quality of ethnographic settings. Comparability has to be achieved (see Sørensen, 2010). I established comparability by defining the concept of influenza preparedness as a quality common to all research settings. Local and national health authorities and the lab were chosen as research settings. I then searched for common patterns and differences which organised how preparedness is practised, achieved, contested, or modified in the different field sites. The ethnographic approach therefore builds upon conceptual and spatial movements between the field sites.

As preparedness is difficult to localise, the pandemic influenza response plans of both cities provided the starting point for the research. The focus of the study was on *urban* preparedness. By approaching the numerous individuals and institutions who contributed to the document, I tried to unravel the complex sociotechnical relationships underlying these plans. From there on, I followed experts in settings as distinct as a virology lab, a warehouse, or the underbelly of a hospital, and tried to understand how they enact preparedness – socially, professionally, and materially – in their respective institutions. Being employed as an anthropologist at a German university, I was willingly invited to perform observations in multiple settings in Germany. Things in London were much more complicated. Invitations to participate in emergency exercises were withdrawn; interviews cancelled or postponed; many emails left unanswered. In consequence, I was thrown back on interviews and occasional observations as the main means of investigation in the UK.

The study combines 67 qualitative expert interviews, participant observations, and document analysis as its main methods. It has been conducted with the help of the project's research assistant Kevin Hall. Experts were approached from local, regional, national, and international health authorities. Experts include people – mostly medical doctors or former military members, but also a small number of nurses, microbiologists, and journalists – working within urban health authorities, the media, blue light services, hospitals, airports, public transport organisations, and other institutions commonly referred to as 'critical infrastructures' (as defined by the European Commission, 2008)[3]. These experts fulfil the functions of emergency planner, pandemic flu lead, business, security or resilience manager, director, scientist, or coordinator. Consequently, most occupied leading positions. Participant observations, with a duration varying from one day to three weeks, were conducted in a virology lab, during a vaccination programme, at medical congresses, at team meetings, and on four emergency exercises. The research team worked its way through an extensive amount of pandemic plans, guidelines, and medical publications. Some empirical work was performed as a team – including myself and Kevin Hall – while other parts were based on a division of labour between the two of us.

The interview transcripts and field notes were coded, organised and analysed using f4 and ATLAS.ti software. Eight categories were identified (see Glaser and Strauss, 2008): emergence (1), measures taken (2), achieving preparedness through local networks (3), management of information (4), self-assessment (5), historical and institutional background (6), planning assumptions (7), and risk (8). This article is based on research findings summarised under the categories 'achieving preparedness through local networks' and 'flows of information'. For each of them, a number of first order categories were assigned. 'Achieving preparedness through local networks' included the categories of local needs, different roles, how things work within the network, conflicts and how to solve them, networking, raising the alarm. 'Flows of information' was categorised into planning assumptions, filtering information, information infrastructures, and friction.

As the empirical data collected throughout these four years are complex and manifold, this article does not claim to present an exhaustive overview over the whole project. Instead, it focuses on those interviews and observations concerned with the translation of abstract global threats into local risks to be known, assessed, enacted and integrated into pandemic planning measures. Its main focus is on London, with the case of Frankfurt being used at the end of each paragraph to illustrate briefly how preparedness is practiced differently (or similarly) in Germany.

Pandemic preparedness in London and Frankfurt: facts and frameworks

In the UK, the anticipation of future threats runs under the rubric of preparedness and resilience, both of which aim to secure cities against terrorist attacks, power failure, and 'natural events' such as flooding, stormy weather, heat waves, or the emergence of infectious diseases. Preparedness is embedded in a larger framework of generic planning approaches. This is how the Greater London Authority (GLA) explains why London needs to be prepared:

> London is generally a very safe place – however there are a number of hazards and threats that could impact the city, and the people and businesses based there. […] In the London Resilience Partnership, we want to make sure that if a major emergency does affect the capital, we are ready to respond and work together to help minimise any impacts. […] When we talk about a 'major emergency', we use the definition given in the Civil Contingencies Act (2004), which is:
>
> - an event or situation which threatens serious damage to human welfare;
> - an event or situation which threatens serious damage to the environment; or
> - war or terrorism which threatens serious damage to security
>
> Our Strategy defines resilience as: the ability to detect, prevent and if necessary to withstand, handle and recover from disruptive challenges. (GLA, 2015)

In London, preparedness is located in collaborative arrangements representing the functional elements of the city (ranging, among others, from blue light services to water, media, transport, and power). These are organised within the London Resilience Partnership, consisting of about 170 widely heterogeneous organisations, and the London Resilience Team, reflecting a legal requirement as implemented in the Civil Contingencies Act of 2004. The members of the multi-agency partnership meet regularly, even in the absence of acute crises. While some are dedicated influenza specialists, others are trained as emergency planners or business continuity managers and, therefore, coordinate the response to different incidents, not just pandemic influenza. The planning framework is determined by the London Resilience Pandemic Influenza Response Plan in its sixth version (GLA, 2014), and complemented by specific plans for Public Health England and the NHS. In the UK, the decision about the respective response phase is taken nationally and communicated to the local authorities, who might then decide on which response measures to spur into action at a regional or local level.

Until 2011, the UK had adapted the linear scheme of escalating phases as depicted by the WHO (a more linear approach was mirrored by the earlier UK National Framework of 2007). The deviation from this concept is often described as one of the most important 'lessons learnt' through swine flu:

> Although the World Health Organization (WHO) is responsible for identifying and declaring influenza pandemics, the UK was well into the first wave of infection when WHO declared a pandemic in 2009. The use of WHO phases to trigger different stages of the local response were considered confusing and inflexible and it was decided to develop a more flexible approach, not driven by the WHO phases and determined nationally was needed for the UK. (PHE, 2014: 12)

Underlying this statement is the belief that pandemic realities might not be congruent with preceding planning assumptions. Additionally, pandemic planning in London in its current form does not represent the final stage of a linear adaption or transfer process. Rather, my fieldwork coincided with the reformation of the UK healthcare system, which impacts on the work and routines of local emergency planners: agencies and institutions disappeared, merged, were newly established or renamed, responsibilities shifted, as did trusted colleagues. At that time, institutional routines, essential to the articulation of pandemic preparedness, had not yet been settled. In addition, some of the current plans came under revision, while other agencies – such as Public Health England – started to develop new plans.

In Germany, pandemic planning is embedded in a different planning tradition that draws upon the rationales of infection control ('Infektionsschutz') and civil protection ('Bevölkerungsschutz'). German constitutional law determines that the federation is responsible for defence against threats such as fires, flooding or war-related hazards. The origins of preparedness planning in Frankfurt can be traced back to the mid 1990s, when Ebola outbreaks in Africa caused concerns among local public health experts, triggered by the city's close proximity to the international airport. One hospital in particular sought guidance from the federal public health agency on how to handle patients with Ebola who might enter the hospital's A&E department. A task group for epidemic disease control ('Arbeitsgruppe Seuchenschutz') was established. Around 1999, when the WHO published their first pandemic preparedness plan, the task group proceeded to develop a first scheme for the management of pandemics in Germany (Fock et al., 2000, 1999).

Only shortly thereafter, some of the members of the *Arbeitsgruppe* started to expand their planning assumptions, and to adapt them to the local needs as articulated by public health and emergency planning experts in Frankfurt, resulting in the first local preparedness plan in 2008. Pandemic planning in Frankfurt, however, is not part of a generic planning approach, but constitutes a distinct area of intervention, lying within the centralised responsibility of the local health authority ('Amt für Gesundheit'). Consequently, the local task forces and work groups preparing for infectious disease outbreaks in Frankfurt are led by the local health authority. They also meet regularly, but they do not constitute a multi-agency partnership, and they do not plan for other incidents, such as power failure. Here, the legal framework of planning is settled by the 'Katastrophenschutz-Dienstvorschrift DV 100' and attributes the operative and tactical leadership of disaster management to the Amt für Gesundheit (Stadtgesundheitsamt Frankfurt am Main, 2008: 7). It is the Amt für Gesundheit, together with the mayor, who acts autonomously in declaring that a pandemic has arrived in the city.

Both cities are among the most import global business locations. In the UK, financial services are categorized as essential services and assigned the same importance as food, water, transport, energy, health, and telecommunications. They are represented in the local resilience forums (Civil Contingencies Secretariat, 2013: 34). Although planning in Frankfurt obeys a different institutional logic, local emergency experts frequently stressed the importance of the Frankfurt trade fair: pandemics endanger the circulation of financial flows. Nevertheless, the financial sector is largely absent from our material. It is not an intentional absence. Rather, we had difficulties in accessing the inner circle of emergency planners within the financial sector and the pharmaceutical industry in both countries[4]. While resilience planning is supposed to obey the rationale of transparency, some parts of the planning seem to be more transparent than others. However, it is necessary to remember that when disease threats are articulated, many other subjects, interests, and policies are present on the scene. What follows in this article considers those very aspects of pandemic preparedness that cannot be reduced to the conceptual guidelines found in pandemic preparedness plans.

Results

Translating microbial emergence into a pandemic event: spatiotemporal dimensions

This subsection starts with a brief consideration of the spatiotemporal dimensions of an influenza pandemic. How does the planning framework articulate the emergence of not just any, but a *pandemic* virus?

As described above, pandemics are considered global events. The development of a pandemic has been objectified into six phases, each mirrored by the escalating response scheme of pandemic preparedness (see WHO, 2015; ECDC, 2015). The pandemic's temporal dynamic manifests itself in the specific chronology ascribed to the development of the event: it escalates. The pandemic phases are each characterised by the boundary-breaching mobility of the virus a) to cross the species border by mutating from an animal virus into a human-animal virus, and b) to spread from 'community-level outbreaks' to other regions. By obeying a spatial logic of regions, as geographer Stephanie Lavau (2014: 8) describes, virological surveillance "produces a well-bound virus that moves from body to body, and place to place. The threat […] is one of incursion, of moving into places and bodies it should not, such as disease-free zones or poultry". The movement of pandemic viruses is portrayed here as a movement from disease-free communities into those already infected with the flu: it is depicted as expansive and reflexive of the virus' natural properties. Community-level outbreaks in no less than two countries in one WHO region equal phase five, while phase six is defined by further community-level outbreaks in at least one other country in another WHO region. Boundaries here are geographical borders that constitute territories and institutional responsibilities[5].

Table 1. WHO pandemic phases (derived and modified from WHO, 2015).

Phases	Description
One	No animal influenza virus circulating among animals has been reported to cause infection in humans.
Two	An animal influenza virus circulating in domesticated or wild animals is known to have caused infection in humans and is therefore considered a specific potential pandemic threat.
Three	An animal or human-animal influenza reassortant virus has caused sporadic cases or small clusters of disease in people, but has not resulted in human-to-human transmission sufficient to sustain community-level outbreaks.
Four	Human-to-human transmission of an animal or human-animal influenza reassortant virus able to sustain community-level outbreaks has been verified.
Five	The same identified virus has caused sustained community level outbreaks in two or more countries in one WHO region.
Six	In addition to the criteria defined in Phase Five, the same virus has caused sustained community level outbreaks in at least one other country in another WHO region.

While the WHO definition of pandemic phases aims to set a global framework for the understanding of and response to pandemic dynamics, not all countries are eager to adopt this framework – the declaration of a pandemic and its respective phases still lies within the responsibility of the WHO on a global scale. In the UK, a (post swine flu) national decision was taken to adopt a planning framework that is not driven by the WHO phases, but determined nationally. Public Health England (PHE) describes the UK response phases as follows:

> The UK approach uses a series of phases: detection, assessment, treatment, escalation and recovery (DATER). It also incorporates indicators for moving from one phase to another. […] The phases are not numbered as they are not linear, may not follow in strict order, and it is possible to move back and forth or jump phases. There will also be variation in the status of different parts of the country reflecting local attack rates, circumstances and resources. (PHE, 2014: 12).

The approach has been made flexible and detached from international frameworks, strengthening national decision-making processes. Similarly, the influenza pandemic preparedness plan in Frankfurt has been adapted to local needs, rather than simply mirroring the WHO phases. In its current version, the pandemic phases, as declared by the WHO, have to be evaluated on the basis of whether cases are occurring locally ("intern: in FFM/Deutschland"), or abroad ("extern: im Ausland"; Amt für Gesundheit, 2012: 11). Depending on the cases' geographical locations, a different set of response measures will be spurred into action. But other than in London, decision-making processes have strong local and federal links and weaker national ties. Although the spatiotemporal framework developed by the WHO is essential to make meaningful statements about pandemic viruses in both settings, the global declaration of a pandemic is not enough to activate the full range of local response measures in London or Frankfurt: technological dimensions are of equal importance.

Translating infection into data: technological dimensions

As described above, microbial mobility is contingent on classificatory schemes, assembling scale, temporal dynamics, and microbial mutability, in order to be translated into pandemic events that *matter*, to borrow Caduff's (2015) expression. Against the backdrop of a pandemic, singular cases of illness and symptoms are drawn into local spaces of pandemic potential through diagnostic algorithms, syndromic surveillance, and diagnostic laboratory tools. Viruses are invisible to the human eye, travel within the bodies of their host organism, and might be present without causing any symptoms. The vast majority of viruses pass undetected. Therefore, it is by no means clear how and when an emerging pathogen arrives in a country such as the UK or Germany. It is also unclear how emergency planning experts know about this arrival. Although the simple answer might be "surveillance systems tell them", there is more to this than meets the eye. Science and technology studies have taught us that knowing is a practice (Law and Mol, 2002). To *know* that a pandemic virus has crossed national borders and arrived in a country, several actors, conditions, and events have to be in place: the 'detection' of the virus depends on devices and actors.

As the mobility of viruses is closely linked to the mobility of their human or animal host, influenza surveillance practices target the host population – not the virus itself. The following examples are derived from the London field sites and illustrate the assembling of the sociotechnical means necessary to make infections tangible and manageable.

First, a virus needs to meet the body of a human host. This host might be a receptionist living in Uxbridge and commuting to Central London. During her ride on the underground Piccadilly Line, someone sneezes right beside her. The sneezing releases droplets, containing mucus, flu viruses, and other microbes. One virus finds its way into her nose. Ventilation introduces it into her lung where the virus attaches to her respiratory epithelia. The receptionist is now a potential host. Virus particles bind to receptors on the host's cells. The receptionist's body then releases IgA antibodies and produces mucoproteins, but her immune response is unable to fight the viral invader successfully[6]. As the virus finally releases its RNA into the host's cytoplasm, viral replication is initiated. Within hours, the host's respiratory epithelial cells produce a large number of virions, soon infecting neighbouring cells (see Behrens and Stoll, 2006: 92–100). Two days later, the receptionist falls ill from the flu. She feels unwell and develops a fever. Soon, her feeling unwell will be integrated into syndromic surveillance systems as she adopts her patient role, calls in sick at work and goes to the local acute service to seek medical advice. At the admission, medical staff make a syndromic diagnosis at presentation, perhaps supported by laboratory diagnostics, as an infection control expert at a local hospital explains:

> In the low season we would try specifically to make a virological diagnosis. So respiratory specimens and then laboratory diagnostics, specifically looking for flu. We try to keep that going for as long as we can in times of laboratory pressures. But if there were a major outbreak with very, very large patient throughput, then we would shift to a syndromic algorithm rather than laboratory confirmation. (Infection control manager, 2013)

Such a virological diagnosis represents a non-sentinel sampling. From this doctor's explanation it becomes clear that each influenza phase enacts a distinct kind of knowledge. There might be things and practices "integral to" this process of knowledge making, but not "integrated within" it (Hinchliffe and Lavau, 2013: 262). In times of pressure, a diagnostic algorithm comes into play. It is provided by the Health Protection Agency (now Public Health England) and includes questions about severity and duration of symptoms. If the patient feels "non-specifically unwell", she might challenge the hospital's triage and isolation plans:

> [In-hospital transmission] was very... It was difficult to track. […] I guess the one thing it really highlighted though was the problem of... picking patients after admission. So it was very easy picking them up if they came in to admission with respiratory symptoms. The ones that... proved a problem were the ones that came in non-specifically unwell... and then became an obvious respiratory case after they got to the wards. (Infection control manager, 2013)

Here it is described how different forms of symptoms are distributed across different hospital sites, multiplying the receptionist's flu-ridden body. Ideally, the patient's symptoms such as 'coughing' are translated into standardised syndromes: the receptionist has now become a 'respiratory case'. Different sites are bridged. The data will be fed into a computer system used to triage hospital patients and to monitor the local disease situation. If laboratory pressures are low, nose and throat swabs of the respiratory case will be taken, put into a small transparent plastic tube, labelled, packaged, and sent to the lab. Local surveillance systems include not only the data-based monitoring of respiratory activity through the hospital, but also networked connections to other agencies:

> We have our hospital data from our own laboratory. So we do viral diagnostics. And we can see when we are starting to get an increase in activity. Within our own in-patients. But also we've got close links with the Southeast London Health Protection. So we look at their weekly data. And also there is an NHS London network that provides weekly flu data. (Infection control manager, 2013)

The infection control manager describes how different forms of knowledge are drawn together: virological data, syndromic surveillance, and case numbers, resulting in what has been termed 'observational knowledge' (Hinchliffe and Lavau, 2013: 272). Surveillance practices bridge the gaps between different areas and technologies of expertise, such as the virological laboratory, clinic, or public health authority, that is, they facilitate the circulation of information (Waldby, 1996). Here is how a virologist at the National Institute for Medical Research explains how this process takes place in the UK's national context:

> General Practitioners [would be] doing two things. One: noting the level of influenza on the clinical signs, and a subset of these collecting samples to be given to the national influenza centre for virus isolation and preliminary characterisation. […] Those then are initially assessed by the national influenza centre. […] They also will have cases in which for example people are particularly ill. And this would be non-sentinel surveillance in which people are, at the national influenza centres,

> are asked to characterise the viruses from these people that are particularly ill with influenza. And those will be also considered because we need to bear in mind that we, if the virus... if there is a nasty virus out there, it may not be picked up so readily by surveillance. But it might be picked up by non-... by the sentinel surveillance, might be by a non-sentinel sample. So the samples come as a mixture of surveillance, sentinel sampling and non-sentinel sampling. (Virologist, 2012)

He pictures a gap between routinised attention and 'nasty' viruses. Surveillance practices make productive use of this gap. In the lab, virologists, technicians, and machines isolate and characterize the viruses found in the swab, they perform plaque-assays or follow PCR protocols and use specific kits developed by the biotechnological industry. Yet, not every circulating virus will be picked up easily by the national surveillance systems, nor does an increase in positive results necessarily originate in an increased rate of viral emergence, as surveillance technologies and viruses intra-act:

> You could have a large city somewhere else without surveillance and you wouldn't pick anything up because nobody was looking for it! So you also have to have good surveillance. And that's what Germany and the UK do! So you pick it up! Because you're good at it. (Virologist, 2012)

Here, the material contingencies of virological surveillance are stressed: success is entangled with its sociotechnical surroundings. In this process, viral isolates are compared to other viral isolates that have been described previously. Does the pattern relate to any known pattern? Or doesn't it?[7] Virological surveillance initiates a meaningful – pathological – connection between coughing patients at A&E and a mathematical entry into a computer database. Surveillance data depict patients as either sick from the flu or healthy, thereby obscuring divergent bodily practices and expressions by translating them into something that is easily comprehensible by public health officials (French, 2009: 110).

Additionally, sentinel surveillance schemes are in place. They are supposed to pick up 'nasty' viruses:

> Consultant: [Most GPs] wouldn't normally take samples from people, if they made a clinical diagnosis of flu or influenza. But certain of our GP practices commit to taking samples from anybody who has flu-like symptoms. And those samples are sent on a weekly basis to the reference laboratories […] The first test says: is this influenza? Yes or no? And usually it's influenza A and that's what previous pandemics have all been. And then they would go on to say: is this H1N1, H3N2, [one] of the viruses that we know cause seasonal flu? And if […] they weren't able to characterise any of the known flu viruses, they would then go on to say, well, this must be a new one that we've picked up. And they would develop the tests. Because they do have the other antigens. So they would be able to then test for a range of H1, H and N antigens. And say: oh look, this is H7N3, or whatever it might be. And then they'd be able to describe that to us. And then […] they can quite rapidly roll out a new test among all of the public health laboratories around England. So within about two weeks of detecting a new virus they can get the testing kit out to… […] So that we could then detect that virus, wherever it was coming in from.
>
> [MW]: […] Would one single [sample of a] viral strain, which has never been described before, would [it] be enough to alarm you?
>
> Consultant: Well, you might need more than one sample. […] But if we were through that detection mechanism, you know, if a new strain were to emerge here […] twenty people in the first week would have it. And some of them would be picked up through that scheme. […] If we detected one new virus, we probably wouldn't put out a major alert. But if over two weeks we had seen six or eight people with exactly the same new strain being picked up through that mechanism, then I think we would declare the early stages of a new pandemic (Consultant, 2013).

Sentinel surveillance, as this consultant describes, mobilises virological knowledge. Data on previous pandemics merge with current antigen concentrations. Again, thresholds are difficult to establish. How many isolates of a new strain are necessary to cause concern? Digital humanities scholar Lindsay Thomas (2014: 298) reminds us that the harnessing of data is always incomplete. By assembling fictional futures and models, the pandemic-to-be is normalised and integrated into the routines and practises of local agencies. The information on whether pandemic viruses have been 'detected' or not is forwarded through global, national, and regional surveillance networks (such as the European Influenza Surveillance Network, the Global Influenza Programme, or Winter Health Watch), but it also travels through other channels and traverses numerous scientific and non-scientific domains, endorsing prevailing assumptions and stories (Burri and Dumit, 2008: 305), as the third subsection will show.

Local agencies have also implemented additional monitoring arrangements to anticipate possible influenza outbreaks. As a means of syndromic surveillance, staff (and sometimes school) absences are monitored and reported. As a member of the fire brigade explains, monitoring goes beyond a mere statistical analysis – it has ″interpretative powers as well″ (Emergency planning team, 2013). In order to release these powers, software systems had to be adapted to translate staff absences into codes signifying 'flu' or 'bad cold'. I learnt that a significant amount of money or time had to be invested into the adaptation of these systems. Thus, a blending of different surveillance practices (sentinel sampling, non-sentinel sampling, syndromic algorithms) generates data supposed to 'mirror' or even anticipate the pandemic situation.

Epidemic conditions, sociologist Martin French (2009) claims, ″make desirable those discursive techniques which seem to admit clear, concise communication. Perhaps no discursive technique claims more clarity than mathematical expression″ (French, 2009: 111). A mathematical foundation makes it easier for knowledge of outbreak events to be transmitted from one area of expertise (such as virology) to another (such as emergency planning) without distortion. Mathematical expressions are common to the different fields of expertise involved in pandemic planning. Accordingly, risk assessment based on these mathematical foundations is commonly depicted as rational, logical, and objective decision-making. STS scholarship on the pursuit of scientific objectivity, however, reminds us that numbers such as those derived from surveillance technologies are never mere representations of nature, but that they are 'materialized relations' (Verran, 2010), powerful devices (Porter, 1995), and socially performative (Bauer, 2013). As such, numbers play a key role in the enactment of risk reasoning: they bridge the gaps between distinct areas of expertise and intervention (such as computer science, population health, or urban governance) and generate powerful new linkages, thereby rendering microbial emergence governable by risk. Accordingly, it is only through systematic technological attention that individual bodily expressions such as sneezing are translated into numerical data to be visualized, communicated, and acted upon[8].

Similar linkages are evoked in Frankfurt where the local health authority plays a key role within this process:

> We are always monitoring the disease situation in Frankfurt. […] So, we get the numbers. […] So, every single case is shown on the map. Spatially distributed. […] And […] in case of a pandemic, if we say… it's a pandemic situation, not depending on any specific kind of pathogen, or if we are threatened by a pandemic situation. Then we'll be provided with the numbers of people calling in sick from the workforce – not their names of course, just the number of people who called in sick and stayed at home. We get these numbers from the university hospital. […] The fire brigade will be doing the same thing. So we'll have an overview of what the sickness absence rate looks like. And if it's up to 10, 15 per cent, then I'll start to get concerned. And will talk to the mayor or the health delegate, and we'll think about activating response measures.[9] (Infection control manager, 2012, translation: MW)

So numbers are monitored on a regular basis. These numbers do not reflect microbial emergence, nor are they identical with the number of influenza infections, but they establish meaningful – pathological – connections between local Frankfurt residents calling in sick, on the one hand, and the global pandemic situation on the other. They constitute a ″productive alliance of knowledge forms and practices″ (Hinchliffe and Lavau, 2013: 259). Pandemic planning in Frankfurt is embedded in a considerably smaller institutional context (consisting of the local health authority, the fire brigade, local hospitals, the police, and the airport). Similar to London, diagnostic algorithms will be put in place in times of pressure. Different to London, the management, not so much the gathering, of data was emphasised as an important area of intervention. Emergency planners invest much time and effort in the construction and modification of 'reliable' modelling software, and strive to determine thresholds, boundaries, and detectors to signify the arrival of an event (the 'Meltzer Modell' has gained some local popularity). Again, this is supposed to render microbial uncertainty governable through risk assessment.

But, even if surveillance systems signal the presence of a virus with a genetic makeup deemed as unusual or risky, a further step needs to be taken to activate response measures: someone has to raise the alarm.

Translating uncertainty into alarm: administrative dimensions

As discussed above, technologies of medical surveillance (algorithms, protocols, kits, swabs etc.) produce cases and data. In what follows, it will be looked at how these cases and data are subject to pandemic ordering attempts. The last step of the translation process encompasses the administrative dimension where pandemics are rendered governable by local emergency planners, resilience managers, and health experts. To become a truly local threat and to activate the local response plans, the alarm has to be raised.

> There is not just one parameter that says: if this happens, we do x, y and z. It's a lot of different things. […] So there are all these different parameters that you have to look at in terms of making a decision […] It is not one set of parameters – you have to consider *a number* of them. And at the end of the day there is no formula. It's your judgement based on what you know about people – or what you don't know about people. And the disease and what's happening within the community. (Pandemic flu expert, 2012)

As this expert stresses, there is "not one set of parameters" signifying the arrival of pandemic flu: knowledge is contested and multiple. The monitoring of microbial mobility and case numbers does not necessarily result in easy decisions. Rather, monitoring produces another set of data that must be transformed into information which needs to be mobilised to reach its target audience (public health officials, the workforce, or the broader public). Different data bases and information systems have to be linked. They "kind of talk to each other", as a member of the health protection team explained – although, as she added with amusement, "sometimes [they] don't talk to each other as well as they should be" (Health protection team, 2013).

Pandemics are often discussed as circulatory processes, or as a crisis of circulation (wherein 'good' circulations have to be facilitated, and 'bad' circulations have to be minimised, see Elbe, 2009: 73). Among the many things mobilised during a pandemic – such as vaccines, fears, alcohol gels, experts, or standards – most experts we interviewed highlighted the central importance of communication: information has to be mobilised in the management of infectious disease outbreaks. This requires efforts, and it requires time. Numbers and concerns need to be communicated; reliable and trustworthy information has to be separated from less reliable and less trustworthy information. Sometimes, not only quality but also quantity of information poses a problem: preparedness produces "too much information". Implicit here are assumptions about which knowledge might count as 'correct' and 'helpful', and which knowledge is rejected or ignored as irrelevant or wrong. Generally, reliable knowledge is attributed to national and international health authorities (with NHS, PHE, WHO, and CDC being the most important ones) and has been validated through lab confirmation. In practice, the mobilisation of trustworthy knowledge requires effort:

> …we have something called the London local authority coordination centre […]. That's actually a conduit for all 30 local authorities. We *take* information to them, we *put* it into a single format, and we give it to those people who need to have it. (Emergency planning team, 2013)

A manager within the London Resilience Team says:

> As far as flu is concerned, [the sub regional resilience forum functions as] a forum for the passage of information and sharing of information. (Emergency manager, 2013)

Both of these statements mirror policy positions, and both stress the necessity to circulate knowledge. Information handed down by public health authorities must be filtered according to the specific needs of the workforce, or any other target group. Filtering is meant to maintain the boundaries between 'good' (that is, trustworthy) and 'bad' (that is, misleading) communication. However, information seems to be vulnerable since it cannot be contained or controlled (as aptly illustrated by SARS in China). Information released by public health authorities competes with other kinds of information that are already out there in the world. During the 2009 pandemic, for example, the German vaccination campaigns were challenged by controversial debates around the risks and benefits of the two different available vaccines, one containing an adjuvant (*Pandemrix*) intended for the broader public, and the other without an adjuvant (*Celvapan*) intended for certain population groups, including the troops and government employees. While government officials and health authorities promoted the campaign, other sources of information (blogs, medical experts, the media, or circulating rumours) displayed Pandemrix' side effects and spread fears of a two-class health system. These informations competed for attention, and – seen from a public health perspective – endangered the successful implementation of the vaccination campaign. 'Good' and, therefore, trustworthy information, as emergency experts claim, is characterised by a reliable and independent source, and by a choice of words that are unambiguous and clear:

> The importance of good communication was a... was a key. […] The importance of having, you know, one voice, one set of figures. […] So that we didn't have someone saying there were 200 cases and someone said 150. It was... It was about trying to ensure that there was a consistency of message that people felt they could rely… (Pandemic flu expert, 2012)

'Good' communication, according to this expert, ensures that health authorities do not produce multiple, or inconsistent pronouncements. Facilitating the circulation of 'good' and trustworthy information is key to decision-making processes. It is useful to note here, that raising the alarm entails *collective* decision-making processes. These processes are articulated with technologies, data, plans, and rationalities: preparedness is achieved through local networks. Parts of these complex structures are manifested in the London Resilience Partnership, but the network extends well beyond the surface of centrally set structures, incorporating friends and colleagues from other agencies and countries (some of whom might have worked in the same lab or met during a conference), as well as manifold sources of information, ranging from daily newspapers to newsletters, blogs, or rumours. Some agencies have employed dedicated 'risk specialists' whose task it is to check websites, read the news, and meet up with other members of the local partnership. A bulletin summarising the weekly events is sent out every Friday by London Resilience, and a monthly NHS influenza newsletter circulates. This is how an expert within NHS England explains how she learns about emerging viruses and makes decisions:

> A colleague from the Health Protection Agency said something is going on, can't really talk to you about it yet, but keep an eye out! Then I picked up through the ProMED digests […] They collect all sorts of news reports of human, animal, and plant diseases. And so those reports are coming through that... So I was observing that... emailed a couple of people to ask what was going on. And there is a patient in a hospital in London, so we know about that through our medical director and our other routes in this organisation. So because... the patient is in a NHS trust in London, we know about it that way. So what I was doing yesterday – apart from everything else I was doing – was trying to understand what we knew about the virus, […] how bad might it be, what's the particular situation. (Flu expert, 2012)

Similarly, an emergency manager within the London Resilience Team describes:

> There is a process to monitor... London on a day-to-day... not on a day-to-day basis, really on a week-to-week basis which is done by London Resilience Team. Public Health England have real time monitoring of disease which they report on a regular basis. We include that in our reports. As soon as we notice a change in the sort of... out of the norm as it where, so for example last week they were reporting a fair number of chest infections.

> But within seasonal standards. Seasonal norms. As soon as there is a change from that there'll be a discussion between us, Public Health England, to assess what measures are now needed to respond. So that could be at the most simple level: exchange information, have a teleconference. Is this sudden impact really big, we need to call the most senior people in now for a meeting, to start identify the strategy. (Emergency manager, 2013)

Obviously, as these quotes illustrate, there are numerous enactments of the pandemic. Different (and possibly competitive) versions of the outbreak have to be measured and compared. In the above quoted examples, a broad range of sources and practices come into play: a chat with colleagues from another agency, maps displaying case numbers, a formalised newsletter, email correspondence, local reporting structures, real time monitoring, standards, statistics, and a teleconference. This kind of networked information management comes as a blending of routinised (and centrally set) reporting structures and more informal channels. It might raise concern, but it is not sufficient to raise the alarm.

Thus, these illustrations seem to indicate that order within complex disease ecologies is only partly achieved through centrally set regulations and laws. Neither is it an individual and autonomous decision of the flu manager in charge (this would also conflict with the command and control structure underlying the centrally set reporting structure in the UK). Rather, order in these extra-ordinary situations is achieved through networked efforts and sociotechnical assemblages. It is the result of co-ordination efforts, as described by Mol (2010).

The situation is fraught with tension: colleagues doubting the severity of the pandemic, disputes about how to head a meeting, media reports displaying the risks of flu vaccines, or members of the workforce refusing to come to work. Tensions such as these have to be bridged, and while not all interviewees agreed upon the measures taken during the 2009 pandemic, they all were eager to stress that the network worked efficiently [9].

The technologies used to perceive, communicate and finally to manage outbreak situations – to achieve coordination – are pretty mundane: telephones, newsletters, PowerPoint software, laptops, and computers. Much of the work being performed by emergency planners does not differ significantly from the work performed by a social scientist. To a large extent, pandemic preparedness is about reading, analysing numbers, looking for information, making phone calls, evaluating information, or meeting with colleagues. Flu experts and emergency planners make phone calls to discuss laboratory findings with colleagues working in Colindale, Berlin or Geneva. They subscribe to weekly newsletters, displaying epidemiological and virological data and reporting on flu activity across Europe. They look at the colourful maps that represent the circulation of influenza viruses and that either offer a global perspective, or a form of representation categorised by country, area, or territory. They initiate teleconferences with their local resilience team, and book meeting rooms and time slots. They analyse numbers to contextualise the epidemiological data provided by transnational health organisations. They read case stories in the newspaper and the social media. They order and stockpile alcohol gel. They meet with the mayor's office to discuss the situation. Is the city at risk? Or is there no reason for concern? The information they assemble is heterogeneous, sometimes contradictory, and reflects the manifold interests of local authorities and organisations. Pandemic preparedness' most important setting is the office[10].

Yet it is noteworthy that pandemic preparedness itself does not aim to impact on the outbreak: it does not seek to stop the pandemic from happening. Rather, its underlying rationale is anticipation, or response. Risks, at this level of the translation process, are discussed as emerging from overplanning, the circulation of 'bad' information, or a declining interest in the imperative of emergency planning (ironically described as 'pandemic fatigue') – they seem to endanger not only the effectiveness of the planning procedure, but also compliance and support from the broader public (see Wolf, 2016).

Similar to London, the management of information in Frankfurt is believed to be key to successful preparedness. Accordingly, 'good' information has to be brought into circulation to make informed decisions. The process is enacted in a comparable way as a networked information management and blends different layers of communication, as this doctor at at local hospital explains:

> ProMED is the most important source. Reading it is part of my morning routine, like having a coffee. […] Then of course the Robert-Koch-Institute. ECDC is included in ProMED…. Well, and personal contacts play an important role. […] We are in touch with nearly 25 EU-member states […] If something is up there, we will be informed through a mailing list. […] But it is not officially legislated, this kind of communication. […] And if you read something and realise 'oh, this happens near Guiseppe', then you would probably write Guiseppe and ask about it (Infection control manager, 2013, translation: MW)

The action undertaken here does not distinguish between 'official' and other sources of information – both might generate concern. As in London, centrally and federally set reporting structures exist in a parallel reality to larger informal networks of friends and colleagues. Interestingly, it is through these very networks that pandemic preparedness exceeds and expands across national boundaries. The decision to raise the alarm, however, is a centralised decision.

Conclusion

This brings us back to the introduction. The article started with the question of how emergency experts know about the arrival of pandemic flu in a given territorial context, and they were found to *know* in different ways.

First, the spatiotemporal framework as set by the WHO establishes criteria to understand the characteristics of a pandemic and to coordinate response measures. Within this framework, pandemic viruses emerge as *novel* bio-agents possessing a different genetic make-up and the ability to master the interspecies barrier. This framework requires the novel virus to spread across national borders and the WHO regions. Acting as a *truth claim*, it develops policies of an escalating and boundary-breaching outbreak dynamics and translates microbial emergence into a pandemic event that can be known and acted upon.

Second, individual cases of illness are translated into data. Here, globally circulating viruses need to be 'detected' by local surveillance systems, assembling patients, sneezing, GPs, blood, hospitals and databases into mathematical techniques that bridge the gap between different areas of expertise. Virologists, public health experts, politicians, and emergency planners are enabled to act upon numerical risk assessments, likelihoods, and case numbers. Here, knowledge is of a statistical nature and derived from numbers displaying likelihood and impact of a pandemic event.

To activate local response measures, a third step has to be taken: concerns need to be translated into alarm. Decision-making processes have proven to be collective enterprises rather than individual and autonomous – it is mostly through networked information management that local experts contextualise surveillance data and informal sources of information. As coordination attempts, networked information management practices aim to manage the circulation of information to, as Mol (2010: 264) claims, keep potentially competing versions of reality out of each other's way. Within this administrative framework, knowing is closely related to reaching consensus and distinguishing between 'reliable' and 'less reliable' information.

When taken together, knowing pandemics in London and Frankfurt shows differences as well as similarities. In both cities, knowledge on pandemics is discussed as governing (through) networks. Both cities enact different layers of centrally set and informal reporting and communication structures and both cities struggle to link different sets of data and to "make information systems talk". But both cities have found slightly different answers to this quest. In comparison, the local networks show different underlying dynamics. In London, the network dynamic can be described as *volatile*. It results from a large number of heterogeneous institutions and plans, as well as from the restructuring of the health care system. Consequently, many agencies tried to resuscitate the network through personal acquaintances and connections. "Making friends with other agencies" was described as a common and effective strategy to take care of networks.

Frankfurt, in contrast, shows an *expansive* network dynamic: local emergency planners stressed a need for integrative, centralised, and coherent governance structures. They have implemented tools (such as a software system to monitor patient allocation from a centralised perspective) to expand their planning approach to other local and regional agencies. Here, to take care of networks might be translated into standardisation and centralisation.

Two conclusions can be derived. First, the above-described examples might illustrate that the concept of disease emergence cannot be reduced to 'naturally' circulating viruses to be detected by international surveillance systems. It can never be *pure* knowledge. Rather, the emergence of influenza viruses within territorially defined regions is only enacted through a set of meaningful relations that enable certain ways of preparedness and response to be articulated (and others to be silenced): it requires hard work and administrative, technological, political and biomedical skills to make a pandemic present and tangible, and it seems doubtful that pandemics constitute sudden events or natural disasters. Displaying the facticity of pandemic knowledge and its epistemological foundation, however, does not mean that this knowledge is false, nor does it deny the reality of people suffering from, or dying of, the flu.

The second thing to be concluded is the observation that local preparedness does not result from a linear adaptation of global health standards, nor does it constitute the movement of policies from the global level to the local – if policy transfer is defined as the intentional, spatiotemporal, and significant movement of "something related to policy from one place to another" (Bissell et al., 2011: 1141). By applying a perspective informed by ontological politics (Mol, 2002), pandemic preparedness seems to alter when viral emergence is moving through global health classification schemes, individual bodies, algorithms, labs, and meeting rooms. Consequently, as studies on implementation and standardization have illustrated (Walt et al., 2004; Aarts et al., 2004), it seems doubtful that the introduction of global health policies results in predictable local outcomes. Global health, seen from this perspective, cannot be reduced to either a medical or an institutional framework, but it is simultaneously social and technological, scientific and political, volatile and expansive – and it relies on uncertainty to govern potential outbreak situations. Uncertainty here is at the same time descriptive about the world (in that it conjures a need for preparedness) as well as performative in the world (in that it reifies an apparatus of security).

When taken together, *knowing* that a nation or a city is struck by pandemic flu constitutes a complex sociotechnical process that transforms microbial messiness – global in scale – into local scale pandemic orders. Pandemic orders are achieved through pandemic ordering practices, a re-arrangement of what can be seen, known, or said within the social context of emergency planning. Pandemic ordering practices do not obey a single logic, and goals of intervention may vary: seen from a business continuity perspective, some measures might contradict the rationales of infection control. Vice versa, infection control measures might endanger business continuity. The head of agency A might have a different opinion from the head of agency B. Many kinds of information compete for attention. People suffering from fever and sneezing might decide to consult a doctor, or they might decide to stay at home. Planning measures might fail. All of which puts pandemic preparedness in a different light. It may well be about centrally set structures, but it is also about the efforts of ordering within different contexts. Pandemic preparedness, seen from a STS perspective, bridges spatial, technological and administrative gaps between globally circulating viruses and local areas of intervention, thereby enacting global health as a matter of local concern and political intervention.

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Endnotes

1 Critical approaches claim that international infectious disease management technologies and the securitisation paradigm mainly meet the needs of Western states, rather than addressing truly global concerns (Davies, 2008; Fidler, 2003).

2 In this paper, the term 'microbe' will be used to refer to both viruses and bacteria. Within the biological sciences, it is currently acknowledged that viruses possess both characteristics: those that support the assumption that viruses are 'dead' biochemical entities, and those that are attributed to the world of living organisms. Thus, viruses transgress traditional binary definitions of living organisms or dead matter (Villarreal and Witzany, 2010).

3 In both research settings, we did not succeed in contacting the police, the stock market, the pharmaceutical industry responsible for the manufacturing of vaccines, or internet exchange services (DE-CIX in Frankfurt counts as the world's leading internet exchange point).

4 The pharmaceutical industry is a powerful voice within global health security: in the UK, for instance, national stockpiles of Tamiflu and Relenza were established to be used as prophylaxis and to treat suspected cases (GLA, 2012). It is estimated that the UK government spent £500m on antiviral drugs (Goldacre, 2014). In 2014, a report published by the Cochran Collaboration reviewed, among others, the efficacy of Tamiflu and found no solid evidence that the drug would reduce the risk of flu-related complications and hospital admissions.

5 The world has been divided into six WHO regions: Africa, the Americas, South-East Asia, Europe, the East Mediterranean and the Western Pacific.

6 While the presence of the virus does not necessarily result in infection, infection in turn does not necessarily result in illness.

7 What lab staff finally sees there, of course, depends on the specific diagnostic tools and procedures as specified by virological protocols: while some aim to identify neuraminidase subtypes, others search for antibodies or rely on haemagglutination inhibition testing (WHO, 2011). In the UK, real-time PCR is used for sentinel virological surveillance.

8 Lyle Fearnley reminds us that if surveillance systems depend on categorical lists of pre-defined diseases, they will fail to detect microbes with uncertain biological make-ups (Fearnley, 2006, 5).

9 To give some examples of the many forms of coordinating efforts undertaken by interview partners: staff members with inadequate hand hygiene had to undergo specific health education routines, 'misinformation' about the risks and benefits of vaccination was met through the release of 'reliable' information, and mistrust was expressed and discussed in informal chats with colleagues rather than through official reporting structures.

10 Of course, many other spaces are included in the crafting of preparedness, such as virological labs, hospitals, pharmacies and public restrooms.