

ARTICLE

# Emerging Disease or Emerging Diagnosis? Lassa Fever and Ebola in Sierra Leone

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ABSTRACT

*It has become routine to attribute the tragedy of the West African Ebola epidemic to inexperience and lack of knowledge. Guinea, Liberia and Sierra Leone were portrayed as entirely unfamiliar with Ebola and therefore without relevant knowledge. The simplicity of this narrative is disturbed by the experience of Lassa fever, an infectious and deadly viral hemorrhagic fever (VHF), which is endemic in the three countries most affected by Ebola. This paper looks beyond Ebola in 2014 to the history of efforts to control VHFs in the Mano River and challenges the idea there was a vacuum of knowledge. Highlighted instead are politics of knowledge which have run through global health and which have prioritized particular forms of knowledge and ways of dealing with disease. Ethnographic research on the emergence of Lassa and the subsequent emergence of Ebola in West Africa is presented, focusing on the development of technologies and institutions to detect and manage both viruses. This provides a lens for exploring what was known and not known, how and by whom; and what was counted and what was not, and why. The anthropological literature on emerging diseases has so far focused on the social, economic,*

*and cultural dynamics which produce disease burdens but less on the socio-technical processes which calibrate these burdens. The paper contributes to the anthropology of emerging infectious disease by more fully accounting for the intricacies, uncertainties and implications of diagnostic and surveillance practices for new diseases. The paper will add to post-Ebola debates around preparedness by connecting intricate sociotechnical perspectives on disease emergence with the politics of science and global health and questioning the way priorities, risks, and problems have been conceptualized within this. [Keywords: Diagnosis, emergence, Sierra Leone, Lassa, Ebola].*

## **Introduction**

In February 2015 I returned to a village in Eastern Sierra Leone where I had conducted some of my doctoral research. Although located in Kenema district, one of the country's initial epicenters, it was thankfully untouched by the Ebola outbreak. Gbessy, a successful tradeswoman, expressed her continuing skepticism about the disease: "the government says that everything is Ebola, but we've had fever before. We've had diarrhea before". The point of this article is to put Gbessy's claim, and that of many who expressed similar sentiments into context, and to consider what that context reveals about the process of disease emergence.

The largest Ebola epidemic in history—which has been characterized by confusion, mistrust, and blame—highlights the urgency of this task. Powerful narratives about underlying causes have cemented stylized understandings of disease emergence. In both the media and responding public health agencies it quickly become routine to attribute the crisis to inexperience and ignorance, compounded by the lack of resources (see Mark 2014, WHO 2014). The states, health systems, and local populations of Guinea, Liberia, and Sierra Leone were portrayed as entirely unfamiliar with Ebola and therefore without relevant knowledge; in this telling a virulent new virus was able to explode onto the scene, exploiting the Mano River's inevitable vulnerability as if nothing could have stopped it. The simplicity of this narrative is disturbed by a closer look at the mingling of viruses, people and detection systems in the region.

In epidemiology, when an apparently new disease is detected it is prudent to ask: is this really new or is it only being recognized for the first

time? Many “emerging” diseases are often nothing of the sort. Indeed, a paper in *Science* titled “Emerging disease or diagnosis?” asked this question of the Ebola, Marburg, and Lassa viruses in 2012 (Gire et al. 2012). Genetic material suggested that these diseases were older than typically appreciated and there was evidence of uncounted infections and possibly immunity in Western and Central African populations. Therefore, once the Ebola virus had been confirmed in Guinea, in March 2014, it was obvious that a group of scientists who had been researching Lassa fever—a viral hemorrhagic fever with similar symptoms to Ebola and which is endemic in Guinea, Liberia and Sierra Leone—should consult the contents of their freezers. Retrieving samples collected in Sierra Leone between 2006 and 2008, which had already tested negative for Lassa virus and malaria, they checked for Ebola: 8.6 percent had antibodies for Ebola Zaire,<sup>1</sup> suggesting the people those samples came from had been exposed to Ebola virus and that the 2013 spillover in Guinea was not the first (Schoepp et al. 2014). They also found evidence of Marburg virus (3.6 percent), Dengue virus (4.3 percent), West Nile virus (3.0 percent), Yellow fever virus (2.5 percent), Rift Valley fever virus (2.0 percent) and Chikungunya virus (4.0 percent).<sup>2</sup>

In this light, Gbessy’s statement reveals important insight rather than ignorance—as has been repeatedly claimed of West Africans who question the “reality” of Ebola. It suggests that significant disjunctures exist between institutions of detection, sanctioned knowledge, and illness experiences, and that the way they are managed is critical. This paper looks beyond Ebola 2014 and traces the shifting techno-science of Lassa fever, especially the development and use of diagnostics and what that reveals about how (some) disease experiences were defined and made to count. Viewing Ebola from this perspective challenges the idea that there was a vacuum of knowledge and recasts the Mano River as a site where knowledge is not only produced, negotiated, and refined, but also muted, concealed, and ignored. By revealing these messier politics of knowledge, this article offers both a re-thinking of emergence and a more contextualized account of Ebola’s inroad into the region. In this version, neither the virus’s emergence nor its devastation are inevitable, but are instead the product of social, political and technical processes as much as epidemiological ones.

To substantiate this view on emergence I draw on participant observation and interviews conducted between 2009 and 2015 in Sierra Leone, on Lassa fever and Ebola. The paper proceeds in five parts. The first

provides an overview of thinking on diagnosis and emergence in the health and social sciences. It argues for a closer reading of the practices and politics of detection. The second tells the history of Lassa fever and the co-evolution of diagnostic institutions, geopolitical concerns and framings of disease, and considers how these laid the ground for Ebola. This provides a departure point for the third section, which offers an ethnographic account of the unravelling of these institutions. It traces the implications of shifting diagnostic practices in laboratory and clinical settings, especially the consolidation of a new category of non-Lassa febrile illnesses in the years preceding the Ebola outbreak. The fourth section locates these changing diagnostic systems in local health seeking practices in order to understand emergence more broadly. Finally, the conclusion considers implications for preparedness and social science.

### **Conceptualizing Emergence through Diagnosis**

The concern of this paper is infectious disease emergence, generally thought to be driven by interacting ecological, demographic, and political-economic processes such as deforestation, urbanization, agriculture, climate change, and so on (Jones et al. 2008). While these drivers are debated, it has long been acknowledged that the surveillance of disease—especially emerging animal-borne infections—is limited in low resource contexts (WHO 2006). It is recognized that much ill-health goes officially unrecognized and unreported and that “new” diseases are often just those being recognized for the first time. However, the “concept of emerging pathogens arising through better diagnoses,” as Gire et al. (2012:750) put it, has received surprisingly little attention in the social science literature on epidemics and emerging infectious disease.

Medical sociologists and anthropologists have rejected the neutrality of diagnostic categories, emphasizing instead their social, moral, and normative dimensions (Jutel and Nettleton 2011, McGann and Hutson 2011). Yet many of the examples in this literature—hysteria, homosexuality, obesity, post-traumatic stress disorder—are of particular kinds of contested conditions, mostly in Western populations, where “a bio-pathological mechanism is either unproven or unprovable” (Rosenberg 1992:XV). Is the diagnosis of a disease with an identifiable pathogen, such as the Lassa or Ebola virus, somehow more straightforward? Controversies over the characterization of HIV and its links with AIDS (Epstein 1996, Fassin and

Schneider 2003) indicate otherwise. The diagnostic profile of AIDS was skewed towards infections commonly observed in men, homosexuals, and intravenous drug users than those which affected women (Treichler 1999). This suggests that in addition to the social construction of disease labels, an equally important dimension to emergence is when disease is ignored, or when it is ignored in some people.

Paul Farmer (1996) highlights the political economy of infectious disease emergence. Socio-economic inequalities, he argues, powerfully determine the distribution and course of modern day plagues. As well as pointing to the economic stratification of disease burdens, Farmer notes that diseases of the poor are less visible: “one place for diseases to hide is among poor people, especially when the poor are socially and medically segregated from those whose deaths might be considered more important” (Farmer 1996:263). It is only when poor people and pathogens find ways to overcome this segregation and “spillover” into more affluent populations that they “emerge.” Yet while the broader point may be true, Farmer’s description of emergence belies the contingencies of disease emergence especially the co-evolution of institutions of detection, global health policy landscapes and experiences of illness, across multiple scales.

Drawing on the work of Andrew Pickering (1993) and Annemarie Mol (2002), I suggest that disease emergence is multiple, unstable, and open-ended. Social studies of science often emphasize the convergence, or closure, of networks of people, pathogens, and technologies which make a disease a “matter of fact” (Latour and Woolgar 1979, Loon 2005). But Pickering focuses on the interactions and accommodations between human and non-human agency in order to highlight the unpredictability of scientific discovery, or in this case, disease discovery. Meanwhile Mol argues that the assemblages of artifacts and relationships in medicine and science do not move inevitably towards closure but instead constitute multiple realities which diverge, co-exist, and co-evolve. Furthermore, ethnographies of low-resource health systems have found that patients and health workers sometimes actively maintain open-endedness and even states of “not-knowing” in response to a lack of effective treatment options (Last 1981, Street 2011).

This focus on the intricacies of emergence complements new perspectives in the literature on epidemics in social science. Arguing against one dimensional understandings of outbreaks as isolated spillover moments, Brown and Kelly (2014) propose the “hotspot” as an ethnographic trope

to analyze the historically grounded relations and material textures of VHF transmission, woven across intersecting human and animal worlds. Their view of transmission as arising from dense webs of activity and agency embedded in histories and economies dovetails with a view of emergence as the product of multiple co-evolving social, technical, political and epidemiological processes. Indeed, they note that Ebola emerges through a “meshwork” of “palm nuts, shotguns, national policies, and colonial pasts” (Brown and Kelly, 2014:288). But less prominent in their analysis is the notion that emergence is fundamentally a recognition process, the politics and textures of which mean some transmission is noticed, or gains significance, while some does not. The next section charts the development of Lassa fever research and surveillance to illustrate how alignments between international priorities and local circumstances have shaped and re-shaped the viral landscape in the Mano River, influencing the terms on which Lassa and Ebola were known and responded to.

### **Histories of emergence: Lassa fever and Ebola in West Africa**

Lassa fever is a potentially fatal viral hemorrhagic fever of the *arenavirus* family whose rodent host is the *Mastomys Natalensis*. Estimates of disease burden range from 100,000 cases a year to 3 million, and are based on poor diagnostics and unsatisfactory sampling (McCormick et al. 1987, Richmond and Baglole 2003). In humans, some people experience severe life threatening symptoms while approximately 80 percent of infections are mild or asymptomatic (NCEZID n.d. a) but again, these are crude estimates. Symptoms are similar to Ebola and other hemorrhagic infections, and can include fever, diarrhea, vomiting, bleeding, facial swelling, fatigue, and body pain. Acute cases can be treated with an anti-viral, Ribavirin, which increase chances of survival if treated early (McCormick et al. 1986). However recent data from a hospital where Ribavirin is freely available showed that the fatality rate for confirmed acute cases was still high, at 69 percent (Shaffer et al. 2014).

Lassa fever has primarily been found in Nigeria, Guinea, Liberia and Sierra Leone. Areas in each country are considered endemic. Recently Lassa’s territory appears to have expanded and cases have been reported in previously Lassa-free districts, and in Ghana (Gire et al. 2012, Sogoba, Feldman, and Safronetz 2012). In December 2014 an outbreak killed nine

people in Benin (WHO 2015). Some Lassa researchers suggest these developments are an “epidemic of diagnosis” as opposed to newly expanded prevalence and that decades of research and surveillance in regions considered to have high burdens have produced artificial “hotspots” and “Lassa-free” zones (see Gire et al. 2012, Peterson et al. 2014). Arising out of these uncertainties, certain framings (Leach, Scoones, and Stirling 2010) of the disease have become prominent, and in turn have influenced what is looked for and where. The following paragraphs describe the events and processes which have been instrumental in shaping understandings of Lassa.

The “new virus disease of man from West Africa,” as Lassa was described in early scientific reports (Frame et al. 1970), came to be identified through African missionary hospitals and their links to US researchers. Dr. John Frame at Columbia University was interested in unexplained fevers and had requested that contacts in mission hospitals send him suspicious samples (Fuller 1974). In 1969, two missionary nurses in the Nigerian town of Lassa died after experiencing sudden illness, including a high fever. When a third nurse began suffering similar symptoms she was evacuated to the US and Dr. Frame was waiting at the airport to take a blood sample and begin investigations. During that early research there were two people who were affected by laboratory-linked infections in the US: one, a senior scientist who survived and the other, a laboratory cleaner who had no known contact with the virus, and yet died. It was with some alarm, then, that Lassa fever arrived on the international health scene.

In the decades after, research on Lassa and other dangerous pathogens was increasingly subject to biosafety regulations (Wilkinson 2015). Research involving the use of live Lassa virus had to take place in BSL-4 (biosafety level 4) facilities, the highest security level, which are expensive to run. The costs associated with developing diagnostics, vaccines, or treatments skyrocketed. As a result, laboratory diagnostics have not been routinely available for clinical purposes in West Africa for most of the period since Lassa fever’s discovery (Shaffer et al. 2014).

In 1972, scientists from the Center for Disease Prevention and Control (CDC)—who had investigated the initial cases in Nigeria—responded to reports of a disease with similar symptoms in the towns of Tongo Fields and Panguma in Eastern Sierra Leone. The CDC set up research stations in Panguma, Segbwema, and Kenema, larger towns in the East. A treatment program was established in Segbwema at the Nixon Memorial Mission

Hospital and run by Dr. Aniru Conteh (Bausch, Sesay, and Oshin 2004). As investigations unfolded it became clear that Lassa was neither new nor unusual in this part of Sierra Leone (McCormick et al. 1987). The areas surrounding Segbwema, Panguma, and Tongo Fields became known as the ‘Lassa belt’ and were the focus of sensitization activities including radio jingles, village outreach, and dramatizations. Faded signs and t-shirts, the remnants of these efforts, can still be seen there today. The onset of civil war in Sierra Leone saw Segbwema attacked, prompting the CDC to pull out of Sierra Leone and the Lassa treatment program moved to Kenema Government Hospital (KGH) where it remains.

With field investigations stagnated, Lassa became firmly associated with the East. Staff I interviewed at the Ministry of Health and Sanitation (MOHS), and other Freetown based professionals, defined Lassa geographically, emphasizing that it occurred in the “Kenema-Kailahun axis” and was not a “national” disease like malaria. Despite its localized framing, Lassa had, as one survivor put it, a “big name.” I was told, repeatedly, it was worse than HIV because it kills so quickly. Bleeding figured highly in descriptions of the virus’s symptomology, and was often imagined in dramatic quantities. Some young nurses admitted, half-seriously, they tried to avoid working in the East to avoid Lassa which was renowned for killing their colleagues.

Public and epidemiological understandings of Lassa have been shaped by fluctuations in international interest in emerging diseases and civil unrest in West Africa. Conflict had made long term research impossible and by the end of Sierra Leone’s civil war international interest had waned. Lassa was described as an “unheralded problem” (Birmingham and Kenyon 2001) and the “poster child of neglected diseases” (Donaldson 2009). It may well have remained this way were it not for the unlikely confluence of local and global health security concerns. In 2004 there was a hospital-based outbreak on KGH’s pediatric ward (WHO 2005) and Dr Conteh contracted the virus from a needle stick injury and died (Bausch, Sesay, and Oshin 2004). There were also cases among expatriates and peacekeepers, and fear that Lassa could destabilize the peace process by spreading panic (see Wilkinson 2015). These events, especially the death of Dr Conteh, were remembered as a “tipping point” by a CDC scientist involved, leading to the establishment of the Mano River Union Lassa Fever Network (the MRU-LFN) in 2004. With support from WHO and the Office of United States Foreign Disaster Assistance, plans were made to establish laboratory capability in

Sierra Leone, Liberia and Guinea, and to improve case management and surveillance of Lassa and other VHF, within and across borders (MRU-LFN 2004). The renewed concern came at a time when epidemic diseases were increasingly framed as security threats. The International Health Regulations were revised to bolster global health security. Projects like the MRU-LFN helped with this agenda by building capacity to enact the new regulations and deal with “priority” and “epidemic-prone” diseases, which included Lassa and other VHF (MOHS 2008:3-4).

On the ground, however, resources for improved case management and surveillance proved limited. A small team of outreach officers, many of whom have worked on Lassa for decades, continue to investigate cases and carry out “passive surveillance”—responding to reports of cases rather than actively looking for them—mostly in Kenema and Kailahun. The cross-border collaboration with Guinea and Liberia did not materialize,<sup>3</sup> and according to the CDC scientist above, “after the glow of the [2004] outbreak faded,” many of the promises made by partners—including NGOs and governments—went unfulfilled. After the MRU-LFN was formed in 2004 there was supposed to be regular regional meetings. However, it was seven years before the next meeting, held in 2011. This meeting came after a spate of infections in the North of Sierra Leone, outside of Lassa’s traditional Eastern zone. Significantly, it was the death of a South African engineer working for a foreign firm which raised the alarm, and it was foreign doctors who treated him at a missionary hospital and arranged for him to be tested for Lassa, among other things (Wilkinson 2013). The exceptional circumstances of this episode go some way to explaining why the meeting was called, but also why the case was noticed in the first place. However, by 2012 a nationwide cholera outbreak had become the pressing concern. Sierra Leone’s WHO country office staff reported that little had been done since the second regional meeting and that people and funds had once again moved on.

Perhaps most importantly for Lassa was the dove-tailing of these efforts with US concerns about bioterrorism. The US anthrax attacks and 9/11 had prompted the US government to assess which pathogens had the potential to cause major disruption, and biodefense became a policy preoccupation (Borio, Inglesby, and Peters 2002; Vogel 2008). Lassa took on increased relevance to policymakers and scientists in the US when it was classified as a “category A” pathogen, the highest ranking of risk for potential bioweapons (NCEZID n.d. b). Since the establishment of

the MRU-LFN, salaries and running costs at the Lassa laboratory have largely been funded by US biodefense research (Wilkinson 2015). One of the earliest of the multi-million dollar grants in Kenema was to develop “Diagnostics for biodefense” (Garry 2004). This unlikely configuration of geopolitical interests transformed Lassa from a neglected to priority disease. In the process, the knowledge architecture for Lassa was dramatically restructured. Before I take this process up in the next section, I highlight how this history also influenced the terms on which Ebola was interpreted and responded to.

The Lassa ward and laboratory became the frontline of Sierra Leone’s “Ebola fight” when the virus first spilled over the border from Guinea. For the first few months of the outbreak in Sierra Leone, beginning in May 2014 (Wauquier et al. 2015), suspect samples were sent to the Lassa laboratory and suspect patients to the Lassa ward, under the oversight of Dr. Sheik Humarr Khan, head of the Lassa ward and an expert in virology. Metabiota, a private research company, and members of the Viral Hemorrhagic Fever Consortium, including Tulane University, who had long term research relationships in Kenema, rushed to establish laboratory tests to confirm Ebola cases. Members of the Lassa outreach team conducted the early case investigations. It seemed, as if the epidemic was in safe hands. Metabiota staff provided technical expertise to the MOHS and declared that Sierra Leone was “uniquely prepared” (cited in Lachenal 2014).

Patients, however, kept coming, first from Kailahun, then Kenema and from increasingly further afield. The Lassa ward was soon overrun, and a new Ebola ward was hastily built by the District Council. In July nurses from the Lassa ward began to contract Ebola, followed by Dr. Khan, who died on 29th July 2014. In total KGH lost over 40 nurses, cleaners, and laboratory technicians. The death of Dr. Khan made front page news in the UK, and, swiftly followed by cases in Nigeria and the US, global panic set in. In Sierra Leone, the demise of Dr. Khan, and the Lassa ward’s matriarchal head nurse Mbalu Fonnies, demonstrated how grave the situation was. Members of the public and response workers, interviewed in Kenema and Kono in July 2015 about their memories of the previous year, commented that these high profile deaths convinced them of the need to take Ebola seriously; if the experts could not protect themselves then who could?

The geopolitics manifested in Kenema’s Lassa program also proved significant. When Ebola entered Sierra Leone, through Kailahun, parallels were drawn with the civil war, when rebels had entered Kailahun from

Liberia. Yet as the epidemic gathered pace, it was a different kind of war and the conspicuous presence of foreign interests in Kenema which provided an alternative interpretation of the outbreak. With doubts over the origin of Ebola already pervasive, connections were made between the biodefense funding (from the US Department of Defense, amongst others) received by Tulane, Metabiota and their colleagues, and the historical involvement of USAMRIID (US Army Medical Research Institute of Infectious Diseases), who had supplied reagents for earlier generations of diagnostics. Certain websites<sup>4</sup> claimed that Ebola was created by the US government, possibly a Lassa-Ebola hybrid, either deliberately as a bioweapon or in an experiment gone wrong. The Lassa laboratory was supposedly the source. What appeared to begin as whispers on conspiracy websites took on increased local significance when, on 23<sup>rd</sup> July 2014 the MOHS posted an update (since removed) on their Facebook page saying they had ordered “Tulane University to stop Ebola testing during the current Ebola outbreak.” Tensions were running high in Kenema at that time. Attempts to remove patients from the Ebola ward and demonstrations in the town met with beatings and tear gas from the army and police. Residents linked the flow of imported cases from all over the country to the deaths of local healthcare workers and alarming levels of transmission within the town. The rumors about bioweapons and the implication that Tulane had done something deserving of removal from the laboratory added another layer to the idea that Ebola was being brought to Kenema from outside and being multiplied by goings on at the hospital.

This section has sketched out the particular sequence of events and interactions which led to Lassa fever being identified, and which have since shaped the scientific and public understandings of the disease. Alongside this, a particular set of framings have emerged around Lassa fever—the big name, the Kenema-Kailahun axis, the security threat, and more recently the Ebola-Lassa hybrid. These framings—or myths as some would appear to be—have at times been helpful in focusing local and international attention. For example, coming under the US biodefense frame secured sustainable research investment which was otherwise lacking. Practically, however, detection architectures clustered around KGH, the laboratory, and Lassa while national, regional, and broader VHF activities did not develop substantially. Yet as the next section shows, while detection of Lassa tightened up other illness experiences fell through the cracks.

## Getting Specific

People infected with the Lassa virus need to be reliably identified in order to isolate them and reduce the chance of infecting others and to ensure they start treatment as early as possible. However, because of Lassa's non-specific symptoms—fever, sore throat, fatigue— diagnosis is beset with difficulties. In the absence of laboratory confirmation, standardized case definitions and diagnostic algorithms were created to assist clinical staff in identifying the disease. Generations of faded algorithms were taped to the wall of the Lassa ward, and distributed to primary healthcare facilities. The simplified case definition promoted for surveillance in 2008 identified Lassa suspects as:

*Any person in or traveling from an endemic area for Lassa fever (eastern Sierra Leone, Liberia, or southern Guinea) with fever  $>38^{\circ}\text{C}$  less than 3 weeks duration not responding to at least 48 hours of appropriate anti-malarial and anti-biotic treatment, typically with chest pain, vomiting, sore throat, and muscle aches (MoHS 2008).*

The effectiveness of these diagnostic aides rely on the virus manifesting in relatively consistent symptoms and on patients and clinical staff behaving in a relatively predictable way. In practice, however, there was variability to treatment protocols. Nursing staff had rules of thumb about what they deemed to be Lassa and how to manage the risks associated with different signs and symptoms. Among healthcare workers in Kenema and Panguma a few key symptoms had currency above others. Bleeding, red eyes, high fever, sore throat, and a swollen face constituted what was known as “classic Lassa.” At Panguma hospital, nurses had added “black vomit” (explained as either “herbs” from prolonged treatment in the bush, or blood) to the list of key signs. In such cases decisions were made to transfer patients to the Lassa ward and to start them on Ribavirin straight away instead of “wasting time” administering antibiotics and anti-malarials. Such caution also reduced the chance that they would have to “play” with the fluids of Lassa patients and thereby put themselves at risk. Almost as important as the “classic signs” is a patient's travel history as, until the 2011 cases in the North, Lassa was so firmly associated with the “Kenema-Kailahun axis.” The doctor treating the South African engineer in 2011 admitted she did not really think it was Lassa even when she sent the sample to Kenema as he had not been in the East, and he was not

bleeding (Wilkinson 2013). It is unlikely that a non-expat case would have received the same attention.

These long established classificatory rules of thumb were disrupted by the arrival of improved laboratory diagnostics. The Lassa laboratory was built in 2006 and in 2007 routine diagnostic tests were introduced. The tests developed were Enzyme-linked Immunosorbent Assays, known as ELISAs, and the diagnostic suite consisted of two tests: one for the infectious agent itself (e.g. the virus), known as antigen, which confirms the virus is in the blood stream and indicates a current infection; the other is for Immunoglobulin M (IgM) which is an antibody produced early in the body's immune response, which can indicate a recent infection. ELISAs work on the principle that antibodies "bind" to antigen, and vice versa, and so if present in the sample being tested the binding reaction will produce a change in color known as "signal." However, if a person has antibodies from other similar diseases it is possible for "non-specific binding" to occur, which can produce what is known as "noise," making the signal less clear or unreliable. Africans, researchers explained, had "sticky serum" meaning their blood was full of antibodies from exposure to high burdens of infectious disease, which increased the chances of non-specific binding. Non-specific binding is one of the reasons the results of Schoepp et al.'s (2014) study could be unreliable.

The trick to developing a diagnostic of this type is to reduce the possibility for noise by developing test ingredients and protocols which ensure binding was as pure as possible. The first generation of tests took two days to run and were prone to non-specific binding. Over the next few years the Lassa test was refined and by 2011 it took only a couple of hours and was considerably more sensitive (as measured by its ability to pick up Lassa cases) and more specific (as measured by its ability to exclude non-Lassa cases).

The laboratory scientists confidently argued that their new diagnostics were re-shaping understandings of Lassa: "Doctors speak for what we know about Lassa" was how one described it, adding that the new diagnostics they were working on would change this. The scientists often referred to the established knowledge and practice around Lassa as "dogma" which they regarded as unreliable. A key departure from the "dogma" was the interpretation of IgM test results, announced in scientific papers as a "new diagnostic paradigm" (Branco et al. 2011). When my fieldwork began in 2009 both the antigen and the IgM tests were considered

diagnostically relevant and a positive result on either test was counted as a confirmed case and a reason for the patient to move to the ward and start treatment. By 2011, IgM was no longer considered a positive Lassa diagnosis. Researchers developing the tests said it was no longer “clinically significant” and that IgM positive patients were “sick with something else.” The rationale behind this was that they thought IgM stayed in the blood much longer than previously thought. IgM patients were considered as having had Lassa and recovered, but not necessarily recently (see also Shaffer et al. 2014). The change in classificatory boundaries represented a considerable departure from established practice. The honing in on viral proteins meant cases of Lassa could be more reliably detected yet it also served to abruptly exclude a wider set of illness experiences, a shift which proved tricky to negotiate for those outside of the laboratory.

The Lassa ward clinical staff reacted to the reinterpretation of IgM with an increased emphasis on how “stable” IgM positive patients were to determine whether they were admitted and treated as an acute infection or not. As one doctor explained, “Lassa patients are unreliable! They can come in one day and be stable and the next day they are bleeding ... they can explode!” His new approach was to observe IgM positives closely as “sometimes they are worse than the antigen patients.” Whereas before an IgM positive result meant a straightforward admission to the Lassa ward and commencement of treatment, the new tests meant there was more, not less, space for clinical judgement. The consequences of these classificatory negotiations could be substantial. Despite the doctor’s claims of close observation this was more difficult when patients were on the general wards. Although some cases were debated relatively extensively, more than once I witnessed patients being lost, having moved beds or been discharged (Wilkinson 2013). IgM positive patients who would previously have been admitted on the Lassa ward thus missed out on the opportunity for more specialist care; care which was still relevant if, in fact, they were suffering from one of the other hemorrhagic viruses now known to have been in circulation.

IgM results were also obscured from patients. There was already an established tendency towards secrecy when it came to Lassa fever; it might be referred to as “LF” or “the bleeding disease.” Health workers justified this by saying patients would panic or not understand. Sometimes patients were told indirectly of their IgM results: “they told me I have been exposed” was what one patient reported. Others were not told at all. I interviewed a

woman who had tested positive for IgM and had been kept on the general ward. It became clear in the interview that she had not received any diagnosis. She asked me to come to the hospital with her to find out from her records. In light of the expectations that improved diagnostic technologies will reduce uncertainty, examples such as this throw into question exactly whose uncertainty is being reduced. Moreover, although health workers may have found it useful to maintain states of “not-knowing,” as Street (2011) has reported, the benefits for the patient are questionable. There are also potential infection implications. When patients leave the Lassa ward they are given a list of rules to follow: precautions to take when eating, going to the toilet, or having sex, which are aimed at reducing further infections as the virus has been isolated from urine, saliva, and semen when it is no longer detected in blood. Considerable efforts are made to trace contacts of confirmed cases on the ward so it is striking that patients in this grey area between acute or past infection do not have their contacts traced and are not warned of risks.

As the diagnostics for Lassa improved it was increasingly clear that many of the cases previously assumed to be Lassa were not. Approximately 65 percent of people tested for Lassa were negative (Shaffer et al. 2014). These people were suffering from VHF like symptoms and had already, supposedly, had malaria and other common febrile illnesses excluded (although this was not reliable). A question raised at Kenema, therefore, was, if these people do not have Lassa, what do they have instead? We can and should not assume that many or any of these people had Ebola. The more important point is about how these substantial levels of undiagnosed febrile illnesses were dealt with.

The trajectories of diagnostic practice and disease management for Lassa fever and Ebola represent contrasting ways of dealing with the risks and burdens of nonspecific diseases, each revealing some salient aspects of the other. Over time, Lassa diagnosis had become more discerning. From initially treating all fevers which did not respond to anti-malarials and antibiotics or which had “classic signs” as Lassa, clinical staff began to exclude the majority of patients who came their way on the basis of IgM and antigen test results. A model of care which was based on the presence of a specific pathogen had been introduced, which at times, saw patients turned away in spite of their wider symptomology.

In contrast, for much of the Ebola epidemic diagnostics were not available, or at least they were so delayed that critical decisions regarding

triage and isolation had to be made without them. As with Lassa, the non-specific symptoms of Ebola made diagnosis challenging. At first the characterization of Ebola had misleadingly focused on bleeding, the absence of treatment and certain death. This framing of Ebola proved unhelpful, encouraging people not to go to hospitals and omitting some of the more common symptoms. Hemorrhaging, if it occurs at all, tends to be in the later stages of the disease. Thus the initial diagnostic profile set an unhelpful precedent. Public health authorities tried to correct this by publishing lists of key symptoms—fever, headache, muscle pain, diarrhea, vomiting, abdominal pain, fatigue— and subtly changing the nomenclature from “Ebola hemorrhagic fever” to “Ebola viral disease.” The illness period was also increasingly conceptualized as consisting of two stages an initial “dry stage” and a later “wet stage” when the chances of contamination were thought to be higher.

While the public health messages tried to introduce some nuance the government introduced a number of blanket policies. A centralized alert phone line—117—was set up and people were told that they should call to report “key symptoms” of Ebola. Most symbolic was the burial policy. The bodies of people who have recently died from Ebola are at their most infectious and funerals played an important role in transmission. The government’s response was to ban “traditional burial.” Instead, *all* deaths were to be treated with precaution and given a “safe burial” by burial teams. In villages like Gbessy’s, which had not been visited by health workers or social mobilizers, where only the resident community health worker attended an Ebola training in the chiefdom headquarter town, such policies made little sense. The Government’s sudden interest in common symptoms and death was enforced with chiefdom bylaws—ratified by Parliament and on the order of the President—which fine people for non-compliance. The oft heard complaint that “everything is Ebola” indicates that these blanket policies were experienced as a state enforced diagnosis, disconnected from people’s own knowledge of their health. The policy represented a significant departure from previous practice, where people were not just “allowed” to be ill and die of other things but where for the most part the state cared little if they did.

This section has highlighted how diagnostics got dramatically better for Lassa fever but that this created real uncertainties over how to deal with the growing number of apparently non-Lassa febrile illnesses. Indeed, as some of the myths of Lassa unravelled—that it was the preeminent “big

disease” which could be identified by “classic signs”—cases which would once have been considered to be Lassa were now discounted as “noise” and lost from view; or at least there was limited clinical or public health management of these cases. In contrast, Ebola ushered in (necessarily for the situation) crude blanket diagnostic systems, to catch all non-specific fevers. The next section consider how changes in diagnostic culture intersects with local health knowledge and practice.

### **Managing “Big Fevers”**

Young (1982:270) has defined sickness as the “process through which worrisome behavioral and biological signs, particularly ones originating in disease, are given socially recognizable meanings.” In Sierra Leone, there are multiple pathways through which an illness acquires socially recognizable meanings, none of which are self-evident or mutually exclusive.

Lassa is notable for the unusual amount of outside attention it attracts. Once a case is confirmed, a team of contact tracers arrive from Kenema, often accompanied by an ecology team to trap rodents, and sometimes by foreign researchers, like myself. When I first visited Gbessy’s village it was after one such a visit, in the wake of the death of a pregnant woman from Lassa. Despite the circumstances, the arrival of these strangers, along with a projector to show films was remembered with excitement. Perhaps because of this recent visit, children took pride in reeling off symptoms. Cases of Lassa, I was told “should be taken straight to hospital” and there should be no delay. The resident healers and imams agreed that they had no remedies for this disease and that the only treatment for Lassa is biomedical. More specifically it should be administered only at a hospital. In terms of prevention, the village authorities passed a new bylaw that forbade the consumption of rodents. This law stated that anyone found eating *arata* (rats) would be fined and if that person subsequently fell sick they would not be taken to hospital. On closer inspection, the apparently straightforward nature of managing Lassa cases was superficial. My enquiries into people’s experiences of Lassa fever, in this village and with survivors across the region, revealed a more uncertain diagnostic pathway.

Although people are familiar with biomedical disease names and make use of biomedical products, it does not preclude alternative understandings of disease and ways of managing health (Bledsoe and Goubaud 1985, Jambai and MacCormack 1996, Leach et al. 2008). Across the Mano

River, health, disease, and death are thoroughly social. Sudden sickness and death is often associated with un-natural occurrences, normally understood to follow either a “social fault” which threatens to disrupt socio-ecological orders, or a curse (Fairhead and Leach 1996). Confessions and reparations are often required to restore the socio-ecological balance, or to counter aggressions. However, health seeking patterns reveal complex and plural categories for disease which cannot be reduced to a preference for biomedical or traditional treatments. Even if nefarious acts are suspected, symptoms are frequently relieved with pharmaceuticals. Whether for serious illnesses or those of a less dramatic nature, people try multiple healthcare pathways simultaneously.

According to Leach, et al. (2008) in neighboring Guinea the salient categories for health seeking relate to gender, strength building versus cures, clear versus obscure sicknesses, types of payment, types of treatment especially injections or oral ones, and classifications of quality. In Eastern Sierra Leone people’s perceptions and practices for dealing with fever reveal a similar approach. Health seeking decisions are based not on specific diseases but on the severity of symptoms, perceptions of the providers, and practicalities in how they can be paid (Wilkinson 2013).

As is common throughout low-income countries (Peters and Bloom 2012) the private and informal sector in Sierra Leone is the source of much, if not most, of the treatments consumed. Private suppliers of healing products and advice are frequently the first port of call. The marketized relationships of healthcare take on moral significance. There is a common perception that Government healthcare workers do not care for patients and are only interested in fees: “*pass yu pull moni*” (not unless you pay, in Krio) is how people routinely characterize the lackluster motivation of staff at Government facilities. In April 2010, the Government introduced the Free Health Care Initiative that provided free treatment to pregnant women, nursing mothers, and children under five (Donnelly 2011). Yet there have been reports that fees are still charged (Amnesty International 2011). In contrast, people in Gbessy’s village spoke about informal providers with respect. Living among the communities they serve, they are often “known” to their patients and are considered to “care.” These providers may accept deferred payment or payment by other means such as rice.

During my doctoral fieldwork in Kenema district, people used both biomedical and Mende (the largest ethnic and linguistic group in the East) names for diseases. The term “Lassa” was new, “we are just learning that

name” noted one of the village elders. Fever was a common complaint. Though there were both Mende and Krio names for different kinds of fevers, the classifications of most practical significance were *kɔɛ wee* (small fever/cold) and *kɔɛ wa* (big fever/cold) in Mende and “ordinary sick” or “hospital sick” in Krio. This terminology fits in with a broader Mende hermeneutic of bigness and smallness. *Kɔɛ wee* passes in a few hours: “*kɔɛ wee* attacks people, they tremble, their body gets warm, then later it goes away” said one man plainly. It is attributed to everyday causes such as hard work in the bush or eating *kol ris* (left over rice, eaten for breakfast): “every time you do hard work you will feel that one” was another man’s knowing description. A small fever, as with other ordinary sicknesses, can be treated using one’s own knowledge or that of village-based health specialists. Treatments included both biomedical or Mende medicines, known as *pu hale* (*pu* meaning white, *hale* meaning medicine in Mende, or *English meresin* in Krio) or *Mende hale* (or ‘leaf’ or ‘herbs’ in Krio). For example, paracetamol, bitter barks, and ginger were common. With persistence and increasing severity a fever can become a “big fever,” and an “ordinary sick” can become a “hospital sick.” The boundaries between a “hospital sick” and an “ordinary sick” are not drawn around particular diseases, but rather on symptom severity. The norm in rural contexts is trial and error and waiting, hoping that the disease can be managed locally (Richards et al. 2015).

Some diseases, like Lassa, are renowned as a “big sick” (a big disease, in Krio). With bigness and hospitals come additional implications: being away from work and farms, traveling long distances and paying large sums of money. Hospital sick can be financially crippling. A young male Lassa survivor explained the fundamentals of treatment options for fever: “If you have money then if you have *kɔɛ* you will go [to the hospital], if not you don’t go anywhere.” Another man emphasized that people only survive serious illness if they have money and family: “when you do not have money you die.” About Lassa specifically he added: “that disease, when it infects somebody, if they do not have family they will die because to take them to a hospital is a big distance.” Such are the social relations of sickness (Young 1982) in Sierra Leone.

The test and treatment for Lassa is free, but this is only relevant once someone is at Kenema. The pathway towards a diagnosis of Lassa is riddled with challenges. It is possible to pay huge amounts and still lose everything. In one mining village, four members of the same family contracted Lassa: three children and their mother. The father described how

when his first child, a boy, got sick he took him to the village health clinic where they said it was malaria. Medicines and injections were bought, but the nurses did not transfer the boy to a hospital until it was too late. As the boy's father put it in Krio: "*time don pass... den no transfer we*" (time passed...they did not refer us). When they were finally referred to Panguma hospital the man decided not to attempt the trip. His son's condition was so bad by then that, in his mind, "he has died already." The child had deteriorated to the point that he could no longer walk, sleep, eat, or talk. Doubtful that he would even survive the journey to the hospital he refused to take him, reasoning that his son would die anyway and he would not pay money for him to die in hospital: "*Ah say no, e don don, na die e dae die so, so ah no go pay no moni*" (I said no, he is finished, it's over, he has died already so I am not going to pay money). A second child fell sick a few days later whereupon the man returned to the clinic. This time there was no medicine and so he took the child to a clinic in a neighboring village. While in the neighboring village his second child died. Upon returning to his village the man found his wife and their third child sick. Finally the nurses from the local clinic called the Lassa team in Kenema. The third child also died; his wife survived, but was left with severe deafness.

Distances to health settings are far and payment is a cruel mediator in the way hospital sick can be managed. In the face of inadequate referral processes and ill-equipped health facilities the health, social, and economic risks are a high-stakes gamble for families. As Ferme (2014) has noted this produces fatalism, of the kind displayed by the father above. Faced with these odds, with no assurance that once you get to a hospital your condition will be helped, it is sometimes the lowest risk strategy to stay put. The tendency towards waiting or using alternative non-hospital based therapies is not superstition, as healthcare workers often describe the behavior of rural residents, but a logical response to inadequate health care.

As Ebola progressed, many of the more obvious obstacles were removed. Treatment was free, and to this was added (although only after some time) ambulance transportation, food, and in some places money for transport home and to replace possessions and clothes destroyed on admission to an isolation facility. However a diagnosis of Ebola brought other costs, the most notable being quarantine of households. For some the stigma and the costs of not being able to work or farm made admitting to a case of Ebola economically and socially impossible.

Notwithstanding the challenge of getting to hospitals, Lassa and Ebola are in many respects archetypical “hospital sicks” for which no home-administered treatments work. However, for some sufferers the hospital was the place to avoid. A resident of Gbessy’s village, the school teacher, explained why when diagnosed with Lassa by a pharmacist he avoided going to Kenema:

People were dying whenever they took them to Kenema hospital. If they are having Lassa most of them will not survive. So really that was my fear! By then Lassa had broken out around here, so any patient which they discovered had Lassa they took to Kenema hospital, if they see that you are not going to survive they will inject you to die.

It is notable that the credibility of this rumor, which was not uncommon in Kenema district, stemmed from the inability of medical staff to treat the disease. Another woman explained that hospital staff used fatal injections in order to minimize spread. The infected person is killed, she said, to “*let it no scatter*” (to stop the disease spreading). As such it is an expression of the ambivalence with which people view hospital healthcare - the motivations of the staff, the hospital’s ability to heal and its general detachment from social norms and values. Ebola fitted into this logic in many ways. Not only did early messaging promote the idea that there was no treatment, and therefore that there was no point in attending a hospital, but the lack of triage made them unsafe. Sick patients were berated for not going to hospital but in reality the hospitals presented little benefit; indeed the care they offered transgressed almost everything which is valued and dignified about health care in Sierra Leone.

Local traditions of healing are holistic (Jambai and MacCormack 1996; MacCormack 1981) and integrated into social, religious and political orders. Ebola and Lassa care, which is in isolation, devoid of touch, with poor sustenance, is anti-social. This contrast was most prominent when it came to death. Burials in the Manor River are complex socio-political events. They can involve strategies to determine the cause of death, to correct transgressions which caused misfortune, to demonstrate good will, to complete unsettled debts and marriage payments (which can also mean natural orders are upset), to return the deceased to their villages of birth and to ensure the dead can transform to ancestorhood (Fairhead 2014). Thus, for Ebola patients, and for the father whose son died of

Lassa, decisions about hospital treatment were about more than money, transmission or compliance with bylaws but about the acutely felt consequences of not giving loved ones a fitting burial.

This section has outlined the pluralism of health seeking in the Manor River region, where biomedical and non-biomedical systems are valued and used simultaneously. But it has also outlined the strain and risks involved in accessing formal health care, and the often unsatisfactory or undignified results. This contributes to a skepticism of hospital and government healthcare, which made Ebola harder to deal with. More broadly, in a very real sense these conditions shape the process of who and what gets diagnosed. “Big” diseases emerge from villages and “ordinary” illnesses when the necessary social, moral and economic relationships align, often conditions do not allow this to happen.

## **Conclusion**

The starting point of this paper was to establish the context of Gbessy's skepticism about the Government's handling of Ebola as a “new” disease. Gbessy's statement reveals not her ignorance of Ebola, or of biomedicine more generally, but her keen appreciation of the ambiguous realities of global health and the practice of biomedicine in West Africa. More than that, it reveals that disease emergence is by no means an inevitable process. It is contingent on co-evolving diagnostic practices, health seeking patterns, and framings of disease, over time and across multiple scales. In fact, there are two processes: one is the sequence of events and diverse technologies through which the symptoms of a sick individual are managed, and the other is the way public and scientific understandings of a particular disease develop over longer periods. It is the interaction between these two processes, and the way they are shaped by social, technical, political, and economic factors, which is important, but underappreciated. The former process is influenced, amongst other things, by factors such as road networks, levels of poverty, past experiences, and the availability of healthcare, culminating possibly in a visit to a doctor and a laboratory diagnosis, but possibly not. Who is sick makes a difference, whether they are an American missionary nurse, a South African engineer, a chief, or a poor subsistence farmer. This all determines if and when “new” diseases are formally noticed. The latter process is grounded in the first, but diseases acquire additional significance depending on

geopolitical events, such as regional conflicts or bioterrorism. These new framings can transform neglected diseases into global priorities, which in turn feeds back into the local health system environment, through new resources and bolstered detection systems.

At every stage and level, political economies of knowledge shape the emergence process by determining what is known, by whom, and how, and what is overlooked. Propelled by biodefense concerns and vertical resources for research, Lassa came into sharper focus in Sierra Leone as diagnostics became more specific and more sensitive. Yet as this happened a new group of people with non-Lassa febrile illnesses, including some Lassa IgM positive patients, effectively fell out of any workable classificatory system and received sporadic clinical management or referral. Their illnesses could not be officially sanctioned which made them hard to deal with on a day to day basis, or to prioritize for resources. The new “diagnostic paradigm” based on improved laboratory evidence of specific pathogen proteins, and excluding “noise,” were in stark contrast to the broader social worlds and practices of care in both hospitals and homes. Clinical negotiations surrounding the results of Lassa IgM patients revealed important limits to laboratory-based ways of knowing. In the context of Mende care giving cultures, the (increasingly) pathogen specific approach to healthcare offered in hospitals for Lassa fever and other “priorities”—which sees some people treated and others not, and some people paid for and others not—can be experienced as deeply anti-social. If Lassa became more specific, and alien from the broader sociality and morality of health, Ebola represented a similar disjuncture but the other way around: all diseases, all deaths, and all fevers were Ebola, or so the government’s clumsily implemented blanket policies implied.

The implications of this emphasis on the intricacies and politics of emergence are multiple. First, inquiry into how diseases are known, calibrated, counted, and constructed adds a new dimension to social science perspectives currently being developed on epidemics and VHFs. The details of Lassa and Ebola presented here expand Brown and Kelly’s (2014) focus on the material proximities of transmission to detection. Indeed, a focus on the material and relational aspects of diagnosis, which is underplayed in the literature on “drivers” of disease, considerably enriches understandings of emergence and its contingencies. The 2015-6 epidemic of Zika virus in Latin America underscores the importance of this perspective. It was difficult to establish a link between Zika infection and microcephaly

because of discrepancies in how each condition was identified; and because neither had been systematically tracked, the reported explosion of cases was hard to verify (Annas, Galea, and Thea 2016).

Second, this perspective makes stark the deficiencies of economic accounts which privilege resource scarcity and reproduce arguments about ignorance. These imply, implausibly, that government coffers and knowledge deficits simply need to be filled instead of asking why resources and knowledge are valued and distributed the way they are. Instead, the Mano River, and any setting in which a new disease may emerge, are sites where knowledge is produced and renegotiated. It is true that the health systems of Guinea, Sierra Leone and Liberia were unfamiliar with the Ebola virus but they were not without relevant knowledge. Resources and expertise around Lassa were considerable but tightly clustered. Importantly, there was local knowledge and experience of sickness which consistently did not count, or which counted for less.

Third, it vindicates Gbessy and others who have questioned the reality of Ebola. Her statement highlights the historically clunky nature of disease classification and management. Discussing different forms of violence in Sierra Leone, Mariane Ferme (1998) has argued that apparently exceptional outbursts of physical violence can be linked to practices and patterns of structural and symbolic violence. These latter forms of violence, Ferme suggests, are at work in the technicalities of state administration. Taxes, elections, and census are experienced—and resisted—as contentious political projects which can lead to inequity and provoke violent disorder. In a similar vein, the spectacle of the Ebola outbreak can be traced to the less visible histories of disease detection and the administration of health services and public health priorities which have been described here. In particular this article describes how the state-sanctioned health system, especially hospital care, is experienced as politically charged, dubiously motivated, arbitrarily organized and notable for the risks involved as much as the benefits. This discussion provides important context for understanding reactions to Ebola and the levels of distrust observed, and adds to the voices putting the epidemic into anthropological and historical perspective (see Moran and Hoffman 2014). To deny Gbessy's insight perpetuates an over-exaggerated faith in the reach and practice of biomedicine in West Africa. The readiness of medical staff, policy makers, and media commentators to dismiss lay questioning of Ebola reveals a troubling tendency to brush valid concerns and ambiguities aside.

Fourth, and finally, are the implications for post-Ebola preparedness efforts. The argument forwarded here makes a strong case for practitioners and authorities to be humble about public health practice (and history) when preparing for, and responding to, epidemics. Surveillance systems, especially in low resource settings, tend to be structured around looking for diseases that have (supposedly) been described and defined. However the institutions and infrastructures built up and around disease detection can be misleading, suffering over and under recognition problems. Vertical programs and passive surveillance systems do little to seek out less accessible experiences, or people and pathogens not captured by existing definitions and priorities. Epidemiological models and prevalence reports routinely mention sampling bias and error but rarely do health authorities engage with the interactions between messy and constrained health systems and sanctioned scientific knowledge. Post-Ebola, preparedness activities would be strengthened by paying more attention to the social and political realities of health seeking and the way “new” diseases and surveillance systems fit in to them. There is a considerable role for social science in developing enhanced listening capabilities which build on, and include, local health perspectives and experiences more completely in disease surveillance and management—or in diagnostic speak, to learn to see “noise” as “signal.” ■

#### Endnotes:

<sup>1</sup>Ebola virus belongs to the Filovirus family. Five strains of Ebola virus have been identified: Zaire, Bundibugyo, Sudan, Reston, and Tai Forest. Only the first three have been associated with large human epidemics, all in Africa. Marburg Virus is also from the Filovirus family.

<sup>2</sup>Antibody data is notoriously unreliable and so these results should be viewed with caution. However, another paper has since reported similar results (Boisen et al. 2015). Findings like these give a plausible indication of how little is scientifically recognized, or officially known, about viral circulation in West Africa.

<sup>3</sup>Although the Liberian Ministry of Health did occasionally send samples to be tested for Lassa.

<sup>4</sup>Last accessed from such as [www.birdflu666.wordpress.com](http://www.birdflu666.wordpress.com) and [www.seeker401.wordpress.com](http://www.seeker401.wordpress.com) on July 29, 2015.

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