Signals, Signs and Syndromes: Tracing [Digital] Transformations in European Health Security

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This article traces the ascent of new digital surveillance practices for European health security in an era of heightened global pandemic vigilance. In doing so, the article demonstrates how the confluence of evolving processes of digitisation and production of new digital data sources have enabled EU health security agents in recent years to enhance infectious disease surveillance through novel digitised practices of epidemic intelligence. Subsequently, the article thus argues that the centralisation of these new epidemic intelligence technologies to the core of EU health security initiatives has been foundational to the ascent of a new blended health surveillance practice operating across the EU, which amalgamates the digitised surface alerts of these new big data surveillance technologies with the long-established and traditional disease surveillance legacies of EU Member States. By utilising the concept of surface knowledge in relation to the ascent of these European epidemic intelligence practices, this article demonstrates the key epistemic and methodological shifts which occur in the production of knowledge, alerts and signals for accelerated infectious disease surveillance and the governing of public health risks within the EU.

I. Introduction

Over the past two decades the European Union and its Member States have sought to bolster disease monitoring and surveillance capacities in response to a cascade of new emergent pathogens, disease outbreaks and potential pandemics. These public health emergencies have included the emergence and rapid spread of SARS, avian influenzas, the Ebola virus, MERS-CoV, and the Zika virus, as well as global resurgences in outbreaks of cholera, tuberculosis and poliomyelitis.

The spread of a pandemic illness across the EU would not only result in catastrophic losses to the lives, productivity and social cohesion of EU citizens across the (currently) 28 Member States, but projected economic losses across the EU from loss of output and disruption incurred during such a public health emergency would exceed €180 billion, as conservatively estimated by the European Commission.[1] The development of monitoring, regulatory and preparedness frameworks to anticipate and to control such a potential outbreak across the EU remains an ongoing and complex process owing to the nature of the Union as a highly developed, densely populated region of

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[1] European Commission, "The macroeconomic effects of a pandemic in Europe- A model-based assessment" <ec.europa.eu/economy_finance/publications/pages/publication708_en.pdf> (last accessed 3 December 2019).

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508 million inhabitants with largely open internal borders and the free movement of EU citizens, but also hosting variety of languages, legal systems and socio-economic contexts.[2]

Faced with growing pandemic prospects in recent years, the EU has increasingly emerged and presented itself as an involved global health security actor. This new role of the EU as both a regional and global health security actor can be observed through a number of significant and transformative developments within global politics, including legislative processes (the ratification of the revised 2005 International Health Regulations of the World Health Organisation), political processes (including the founding of the Global Health Security Initiative, in which the European Commission (EC) serves as member), legal/judicial decisions (including Decision No 1082/2013/EU on serious cross-border threats to health[3]), and the development and deployment of medical countermeasures (MCMS, including Tamiflu) across EU Member States.[4] Alongside the development of these new processes and initiatives for enhanced European health security, the EU has consistently emphasised the critical and foundational role of infectious disease surveillance in efforts to detect future emergent public health emergencies.[5]

Situated within larger discussions in this special issue on the logics and practices which illustrate the increased European governance of health crises and disaster management in the 21st century, this article seeks to unpack transformations and shifts occurring within European health security practices in an age of digitisation, digital data growth and heightened EU vigilance regarding the onset of epidemics and pandemics. Critically, this article will demonstrate how the confluence of evolving processes of digitisation and production of new digital data sources have enabled EU health security agents in recent years to operationalise accelerated infectious disease surveillance through novel digitised practices of epidemic intelligence. Subsequently, the article thus argues that the centralisation of these new epidemic intelligence technologies to the core of EU health security initiatives has been foundational to the ascent of a new blended health surveillance practice operating across the EU, which amalgamates the digitised surface alerts of these new big data surveillance technologies with the long-established and traditional disease surveillance legacies of EU Member States.

By tracing these digital transformations occurring within contemporary EU health surveillance practices, the article is structured as follows: Section II will present a brief overview of the long and concomitant nature of disease outbreaks and concerns for European health and population security. It will demonstrate how surveillance processes developed in early European modernity have long served as vital operations

[2] E Speakman et al, "Pandemic Legislation in the European Union: Fit for purpose? The need for a systematic comparison of national laws" (2017) 121(10) Health Policy 1021.

[3] P Kłosińska-Dąbrowska, "Tracing Individuals under the EU Regime on Serious, Cross-border Health Threats: An Appraisal of the System of Personal Data Protection" (2017) 8(4) EJRR 700.

[4] S Elbe et al, "Securing circulation pharmaceutically: Antiviral stockpiling and pandemic preparedness in the European Union" (2014) 45(5) Security Dialogue 440.

[5] A Nicoll et al, "Developing pandemic preparedness in Europe in the 21st century: experience, evolution and next steps" (2012) *Bulletin of the World Health Organization* <www.who.int/bulletin/volumes/90/4/11-097972/en/>.

in the regulation and forecasting of coming epidemics and pandemics. Critically, however, the section highlights how increasingly from the mid-20th century onward, European health surveillance practices have been problematised by the rapid emergence and spread of new deadly pathogens, and the need to rapidly collect more surveillance data to regulate the spread of novel viruses and infections.

In what follows, Section III traces the rise of new digital data sources and practices for the accelerated detection of disease outbreaks which threaten European health security in the early 21st century. The section will show how processes of digitisation and production of new digital data sources have enabled EU health security agents in recent years to operationalise infectious disease surveillance through novel digitised practices of epidemic intelligence. Subsequently, Section IV develops a critical discussion on the ongoing and transforming nature of these knowledge practices related to European disease surveillance in the digital era. By drawing upon and utilising Weir and Mykhalovskiy's concept of surface knowledge in relation to the ascent of these European epidemic intelligence practices, the discussion demonstrates the key epistemic and methodological shifts which occur in the production of knowledge, alerts and signals by these systems for the governing of public health risks. In presenting the ascent of new blended health surveillance practice operating across the EU, the article further seeks to temper and moderate the celebratory claims of the capacities of such big data-driven systems for the bolstering of European health security by attending to the inherent messiness of these epidemic intelligence systems as novel risk regulating technologies.

II. Disease, surveillance and European security

1. A brief genealogy of European infectious disease surveillance

Links between the emergence of infectious disease and the security of populations are long established in the collective history and experience of "Europe". Across the European continent, the onset of plagues, pathogens and infections within cities and states have represented the gravest of risks to the continuity of European populations for centuries; from the recurrent waves of the Black Death and cholera across Europe, to the devastation wrought by the "Spanish Flu" H1N1 pandemic, to the public health emergencies of the 21st century marked by SARS, H1N1, H7N9, MERS-CoV, and the Ebola virus which spread globally and penetrated the frontiers of the EU.

Faced by a continued epidemic of epidemics[6] which have entered the continent from various places, points and ports, efforts towards the containment of deadly viruses, and the restriction of movement of infected persons have long been central focuses of European statecraft to regulate disease outbreaks. Such early European initiatives towards the control of outbreaks of smallpox, plague, and cholera featured the implementation of naval quarantine, aimed at regulating the spread of deadly diseases into European states and preserving expanding nodes of trade and global capital.

6 J Bartlett, "An Epidemic of Epidemics" (2014) Medscape Infectious Diseases.

In the late 18th century novel perspectives in exposure to smallpox and the control of such recurrent epidemics took new regulatory forms observed in the practice of population inoculation, following the development of a vaccine derived from the cowpox virus by Edward Jenner, an English physician. As observed by Foucault during his tenure at the Collège de France, the development of the smallpox vaccination and the subsequent inoculation campaigns which followed, were extensively guided and informed by the avalanche of statistical numbers of the modern scientific era, and represented new epistemic shifts towards the biological governing of European populations and the surveillance of infectious disease.[7]

Surveillance practices and tracking of infectious disease outbreaks expanded significantly into the 19th and early 20th centuries, occurring in tandem with scientific, social and technological advancements which in turn facilitated the implementation of sentinel surveillance systems across major European urban centres. These expanding surveillance practices were underpinned by the systemic weekly logging and reporting of population health data, detailing incidences of disease and deaths stratified by cause, age and sex,[8] and these statistical models were utilised to evaluate and implement disease surveillance and control measures within European states. Moreover, these modern practices of European public health surveillance were largely exercised by institutions of sovereign states with limited inter-state cooperation in areas of containment. The infectious disease reporting activities of European states were then disseminated in the form of "weekly reports" which noted diseases of critical health or strategic importance related to the security of the population.[9]

2. The globalisation of pathogens and "waves" of computerisation

Although these methods of clinical and population-based health surveillance served as the pillar of European infectious disease control initiatives for over a century, established practices of manual data accrual, logging, processing and the dissemination of infectious disease reporting would become increasingly problematised in the wake of epidemiological transitions and rapid technological advancements of the latter 20th century. Critically, owing to expanding processes of globalisation and compacted airline transportation mid-century onward, disease surveillance systems operating within the European Economic Community (EEC) were hindered by an increasing crisis of data scarcity required to estimate and respond to a host of emerging pandemic threats, including the H3N2 "Hong Kong" influenza pandemic, which killed over a million people worldwide in the 1960s and 70s, and the emergence of new zoonotic infections including the Ebola virus, the Lassa and Congo-Crimean haemorrhagic fevers and the Monkeypox virus. Within the borders of Europe, the Marburg haemorrhagic fever emerged in the late 1960s in several cities across

[7] M Foucault, *Security, Territory, Population Lectures at the Collège de France 1977–1978* (Picador 2007); M Foucault, *The Birth of Biopolitics Lectures at the Collège de France 1978–1979* (Picador 2008).

[8] L Simonsen et al, "Infectious Disease Surveillance in the Big Data Era: Towards Faster and Locally Relevant Systems" (2016) 214(4) The Journal of Infectious Diseases 380.

[9] C Castillo-Salgado, "Trends and directions of global public health surveillance" (2010) 32(1) Epidemiologic Reviews 93.

West Germany after laboratory staff had been infected by handling monkeys imported into the country from Uganda.[10] On the frontiers of the EEC, at least 30 other previously unobserved infectious agents rapidly emerged across the globe in a flurry from the 1970s onward.

Occurring alongside these new acute infections, emergent techniques of digital data production and waves of computerisation[11] were gradually adopted into many facets of European life, particularly in areas of government and administration, including in healthcare. These new capacities to produce, store and analyse digital data due to the ubiquity and convenience of computers laid the foundations for the development of electronic health records and health information systems both in Europe and North America. Critically, amid these digital and computational shifts, in 1984 the French government launched the *Réseau Sentinelles* (Sentinelles Network), the first of kind digitised disease monitoring system which reported upon and tracked the prevalence of a range of infectious diseases from influenza, mumps and respiratory illnesses from data sources input by medical practitioners.[12] This experiment and piloting of France's first digital disease monitoring network thus represented new capacities increasingly offered by expanding computation and informational networks of the coming digital age to track and regulate the emergence of potential pandemic threats across Europe.

III. Diffusion of data and shifting paradigms of [digital] surveillance

1. An expanding "European" mandate for pandemic governance and response

These emerging trends of digitisation of European infectious disease surveillance practices would intensify further into the late 20th century and early 21st century amid new geopolitical shifts marked by the identification of seemingly incalculable global security risks. Specifically, as Aradau, Lobo-Guerrero and Van Munster[13] have discussed, whereas "traditional" security challenges such as military aggression, invasion or nuclear threat were essentially predicated on the possibility of empirically identifying and assessing threats via established systems of calculation, deduction and probability, the public emergencies of the early 21st century, such as pandemic illness and terrorism, on the other hand, represented inherently *uncertain* and *unknowable* security risks. These risks, which were enabled by processes of globalisation, and which could occur at any particular time resulting in significant societal disruption, could only be addressed via systems of *preparedness*, in tandem with the development of *technologies of risk* with which to assess, manage and forecast upon a range of possible contingencies.

Subsequently, amid heightened anxieties of bioterrorism and intensifying global pandemic prospects, the newly inaugurated European Union (EU) assumed a new

[10] D Heymann, "Emerging and Re-emerging Infections" *Major Health Problems* <www.ph.ucla.edu/epi/faculty/detels/PH150/Chap9-17_OTPH5.pdf> (last accessed 3 December 2019).

[11] B Rieder, "Beyond Surveillance: How Do Markets and Algorithms "Think"?" (2017) 31(8) Le foucaldien 1.

[12] A Valleron, "A Computer Network for the Surveillance of Communicable Diseases; The French Experiment" (1996) 11(76) American Journal of Public Health 1289.

[13] C Aradau et al, "Security, Technologies of Risk, and the Political" (2008) 39(2–3) Security Dialogue 147.

strategic and assertive role seeking to regulate and contain the threat of pandemic, at both global and European levels in the new millennium. In 2001, the EU and its Member States held the first European pandemic planning workshop, which laid out design for European legislation for health security.[14] In the wake of the 9/11 attacks on the United States, and the subsequent Amerithrax biological attacks, the EU released the European Security Strategy in 2003, in which it made explicit reference to the security risks inherent in the spread of new infectious diseases, and emphasised further the need for effective prevention, detection and responses to global pandemics.[15] In 2005, following the global spread of SARS out of China in 2002/03, the EU established the European Centre for Disease Prevention and Control (ECDC) with a specified directive to strengthen Europe's defences against infectious diseases via the surveillance, monitoring and reporting of 58 communicable diseases from all 28 EU Member States, as well as Norway and Iceland.

2. The rise of European epidemic intelligence

Amid the increased assertiveness demonstrated by the EU as an emergent actor in the politics of pandemic regulation, the early 2000s saw the opening and pushing back of new data frontiers, facilitated by the widespread availability of Internet access, global growths in mobile devices, online sharing platforms and communication forums.[16] Critically, this new and widespread availability of open-source data changed the way in which surveillance data for infectious disease outbreaks could be accessed, disseminated and operationalised. As Paquet and colleagues have argued, these new streams of open-source digital data from the 2000s onward provided new and expedited shortcuts to traditional reporting and surveillance mechanisms that travel through the various levels of European public health administration and infectious disease surveillance programmes.[17] These new public health techniques, which sought to amass, aggregate, and report upon the increasingly abundant digital data streams found online, thus gave rise to novel methods and practices of knowledge generation which could be leveraged to rapidly detect pandemics in the early 21^{st} century, known as epidemic intelligence.

From the surveillance mandate of the ECDC, epidemic intelligence refers to the "systematic collection and collation of information from a variety of digital sources . . . to support the rapid assessments of [pathogenic] risks and the options for response. The objective of epidemic intelligence is to rapidly detect and assess public health events of any origin to ensure the EU's health security".[18]

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14 A Nicoll et al, "Developing pandemic preparedness in Europe in the 21^{st} century: experience, evolution and next steps" (2012) 90 Bulletin of the World Health Organization 311.

15 European Union "European Security Strategy- A Secure Europe in a Better World" <europa.eu/globalstrategy/en/european-security-strategy-secure-europe-better-world> (last accessed 3 December 2019).

16 E Vayena et al, "Ethical Challenges of Big Data in Public Health" (2015) 11(2) PLOS Computational Biology 1.

17 C Paquet et al, "Epidemic Intelligence: A New Framework for Strengthening Disease Surveillance in Europe" (2006) 11(12) Eurosurveillance 665.

18 European Centre for Disease Prevention and Control "*Epidemic intelligence and outbreak response*" <ecdc.europa.eu/en/about-us/what-we-do/epidemic-intelligence-and-outbreak-response> (last accessed 3 December 2019).

New forms of epidemic intelligence, distinct from traditional diagnostic health surveillance practices, aimed to capitalise upon the breadth and diversity of unofficial data sources online and sought to capture and operationalise non-diagnostic data – to generate information on possible health events before, or without, definite laboratory confirmation. The swift authorisation and integration of epidemic intelligence as an evolving method of disease surveillance within the EU exponentially expanded sources of surveillance data which the ECDC would now be permitted to receive in its assessment activities of pandemic risk across its Member States and within its borders; ranging from online blog posts by Internet users (Flutracker), to veterinary and animal health reporting (World Organisation for Animal Health) to news and media aggregation services, and digital disease surveillance systems (the Global Public Health Intelligence Network). As Mostashari and Hartman have emphasised, the ability to detect potential outbreaks in a timely manner through processing unofficial non-diagnostic sources remains the ultimate objective of these new digital surveillance practices.[19]

Arguably, these recent initiatives by EU health authorities to integrate and operationalise new methods of open-source data analysis and epidemic intelligence differ greatly from the established disease surveillance and verification protocols which long informed and guided the monitoring of disease outbreaks in European states in the pre-digital age. Critically, situated within an era of expanding data sources and intensifying technological infrastructures for the uploading and rapid exchange of new forms of epidemic intelligence, the article now turns to the concept of digital surface knowledge production as a framework in which to understand the recent emergence of digital EU health security practices in the 21st century.

IV. Surface knowledge and digital disease surveillance

The concept of surface knowledge within the contexts of disease surveillance and pandemic vigilance was originally introduced in the works of Lorna Weir and Eric Mykhalovskiy.[20] For the authors, the rise of surface knowledge oriented health surveillance practices (which includes digitised epidemic intelligence), stands in contrast to preceding forms of depth knowledge which traditionally guided the public health surveillance of populations. Accordingly, clinical medicine, as well as traditional processes of disease surveillance which were operationalised within European clinics, hospitals and laboratories, were examples of depth knowledge which sought to "link signs and symptoms visible on the body's surface with events found in the body's interior".[21] By contrast, as the authors have asserted, public health practices, including disease surveillance methods infused with surface knowledge have become increasingly prevalent throughout the late 20th century in the wake of technological innovations and advancement.

19 F Mostashari and S Hartman, "Syndromic surveillance: A local perspective" (2003) 80(2) Journal of Urban Health: Bulletin i1.

20 L Weir and E Mykhalovskiy, *Global Public Health Vigilance: Creating a World on Alert* (Routledge 2010).

21 ibid, pp 146–148.

Unlike preceding forms of depth knowledge, surface knowledge "is not organised in terms of a division between the interior and exterior; it does not operate in terms of deeper inner causes, it seeks rather to identify surface patterns or relays in complex networks".[22] One such prominent example of new surface knowledge generating approaches to disease surveillance was the piloting of Google Flu Trends, an online disease-tracking system designed by tech giant Google. Launched in 2008, the digital disease surveillance technology sought to forecast and generate alerts on influenza infection rates by aggregating and analysing up to 50 million of the most common queries related to influenza from its online Google search engine. In demonstrating new capacities to leverage and analyse non-medical, digital data sources for issuing new outbreak detection alerts, Flu Trends claimed that its surface knowledge predictions and estimations of influenza patterns were consistent with traditional surveillance forecasting issued by health agencies including Centers for Disease Control and Prevention (CDC).

In efforts to bolster the real-time monitoring and regulation of pandemic risks, both within its jurisdictions and globally, the EU has moved swiftly to integrate practices of surface knowledge generation of disease outbreaks into its health security operations in the early 21st century. Indeed, in moving beyond the sole operation of epidemiological and clinical and case-based surveillance practices which were hallmarks of public health and population regimes of European states, the EU has further sought to inform and practice its health security programming – including disease surveillance – through knowledge generating techniques rooted in non-medical and unofficial data and using digitised information of events for the basis of issuing alerts.[23] In efforts to get ahead of coming epidemic curves in the digital era, the EU and its central surveillance hub the ECDC have demonstrated novel recourses to the employment and receipt of digitised surface knowledge from new epidemic intelligence technologies. In what follows, the discussion presents and unpacks three such technologies, which feed off expanding sets of unofficial online data, and which have been utilised increasingly by EU health security officials to supplement the forecasting of disease outbreaks in an age of global pandemic vigilance.

1. The Global Public Health Intelligence Network (GPHIN)

Early efforts to monitor the onset of pandemic illness within the EU via new methods of epidemic intelligence gathering can be traced back to the debut of digitised disease surveillance systems of the early Web 2.0 era. The first of these systems, the Global Public Health Intelligence Network (GPHIN), was piloted by the Government of Canada in 1997, and sought to accelerate the detection of forthcoming pathogenic risks by scanning and analysing online news and media aggregator services which might indicate the emergence of an unusual public health episode.

The central operating logic which guided the GPHIN pilot was that by combining new advancements in data-mining and online media aggregation, alerts and

22 ibid.

23 ibid.

indicators of disease outbreaks, as reported in non-medical media sets, might accelerate the awareness and response to potential health emergencies, still unconfirmed by ministries of health or health practitioners. A key issue which faced the architects of the GPHIN system from its original design, however, was the sheer volume and expanse of digital content expanding online. In seeking therefore to speed up the process of data collection, filtration and classification of its epidemic intelligence indicators, the creators of GPHIN implemented an automated web-based system which utilises a digital algorithm to scan and analyse over 20,000 online news reports and over 30,000 sources in nine languages worldwide for potential indicators or signals of outbreaks, and subsequently to forward outbreak alerts of high significance to a multilingual, multidisciplinary team for further analysis and verification.[24]

By implementing these new data accrual and extraction capacities to produce disease alerts culled from piles of informal online data sources, the early GPHIN system demonstrated great operative success in the advanced forecasting of numerous public health emergencies. Critically, this potential to digitally track emergent disease outbreaks by processing unofficial and digitised data was not lost upon European health security practitioners. In 1998, based on Decision 2119/98/EC of the European Parliament and the Council, European health security officials established the Early Warning and Response System (EWRS) of the European Community, a novel web-based communication system which enabled the Commission and public health authorities in the Member States to communicate in real-time and coordinate responses to emergent public health emergencies.

In establishing this new information exchange network for enhanced pandemic surveillance, the GPHIN system was incorporated into the EWRS as a new critical technology for epidemic intelligence reporting. Within the then EC's initiatives to monitor pandemic risks, GPHIN became the first of kind disease surveillance system to turn towards new practices of generating surface knowledge and alerts of potential disease outbreaks by employing algorithms to search, filter and classify online media and news content for the purposes of accelerated disease surveillance.

The GPHIN system was widely credited for its central role in the advanced alerting of the 2002/03 SARS outbreak in South-eastern China, and was cited for its initial detection of the first case of the Middle Eastern respiratory-syndrome related virus (MERS-CoV).[25] Since the founding of the ECDC in 2004, the GPHIN system has constituted one of the primary sources of digitised epidemic intelligence for the centre's monitoring of potential outbreaks occurring within and external the EU Member States.

2. The Medical Information System (MedISys)

By the early 2000s, European health security interests began to focus on the development and piloting of domestic, European epidemic intelligence technologies which, like

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[24] M Dion et al, "Big Data and the Global Public Health Intelligence Network (GPHIN)" (2015) 41(9) Canadian Communicable Disease Report 209.

[25] ibid.

GPHIN, could further supplement the detection of coming public health emergencies through the analysis of open-source digital content. In 2004, the Joint Research Commission (JRC) of the European Commission established The Medical Information System (MedISys); the EU's own epidemic intelligence system with the capacity to scan, assess and extract alerts and surface indicators of public health threats. In seeking to build upon the automated collection and analysis of online data established by earlier epidemic intelligence systems, the MedISys prototype integrated evolving digital processes including text-mining of open-source data and the 'Pattern-based Understanding and Learning System' programme based at the University of Helsinki to extract alerts and information pulled from aggregated media sources.

With expanded digital capacities to monitor and extract disease alerts from over 100,000 online sources per day, the MedISys system has accelerated the notification and reporting of public health emergencies pertinent to European populations. Since its launch the system has been credited for its role in disseminating alerts on numerous public health emergencies including the global spread of the H1N1 "swine influenza" in 2009, an outbreak of dengue fever on the Portuguese island of Madeira in 2012,[26] and the reporting and monitoring of incidences of Middle East respiratory syndrome (MERS-CoV) in EU Member States following the emergence of the novel coronavirus in 2013. Beyond its role in supporting outbreak detection for European health security, the MedISys system has also been incorporated as a key purveyor of epidemic intelligence for global health partnerships including the Global Health Security Initiative (GHSI). Over the past decade, the system has continued to supply outbreak alerts to EU Member States and international health organisations abroad of high-profile global public health emergencies including the 2014 global resurgence of poliomyelitis, the 2014 West African and 2018 DRC Ebola outbreaks and ongoing cholera epidemics in Haiti and Yemen.

3. HealthMap

A third epidemic intelligence model which produces surface knowledge disease alerts extracted from big data sources is HealthMap. An open-source surveillance platform developed by Harvard Medical School, the HealthMap system went into operation in 2006. Highlighting this shift towards the production of surface knowledge for accelerated disease surveillance, HealthMap seeks "to bring together disparate data sources, including online news aggregators, eyewitness reports, expert-curated discussions and validated official reports, to achieve a unified and comprehensive view of the current global state of infectious diseases and their effect on human and animal health".[27]

Like its preceding epidemic intelligence counterparts GPHIN and MedISys, the HealthMap system seeks to extend and intensify the generation of real-time alerts of

26 N Collier, "An overview of Internet biosurveillance" (2013) 19(11) European Society of Clinical Microbiology and Infectious Diseases 1006.

27 HealthMap <www.diseasedaily.org/about> (last accessed 3 December 2019).

disease outbreaks occurring globally by applying big data analytic processes to informal, online and unofficial data sources. Launched in an era of growing informational and data complexity, the HealthMap system sought to analyse big data sets, and provide broad coverage of ongoing outbreaks without overwhelming the user.[28] Subsequently, the HealthMap system features the large-scale integration of a range of digital algorithms which are integral to the successful running of its continual disease surveillance operations. The fully automated system utilises text-processing algorithms to classify the location and profile of the particular disease alert, and then to further visualise and upload these alerts to a digitised, interactive geographic map.[29] The HealthMap system is further regulated by an onsite team of programmers and engineers who seek to address and correct misclassifications and to examine geographic coverage, both of which might vary in accuracy depending on the quality of the particular data set analysed by the system.

These surface knowledge alerts of the HealthMap system were perhaps made most famous in the early critical months of the 2014 West Africa Ebola outbreak. During this period, HealthMap's text-processing algorithm identified a vague media report extracted from the bulk of hundreds of thousands of online sources which detailed the emergence of strange haemorrhagic fever (étrange fièvre), observed in Macenta Prefecture, Guinea which had already killed a number of people.[30]

Following HealthMap's generation of this disease alert on its web interface, 10 days later the Guinean Ministry of Health first notified the WHO of an expanding Ebola outbreak occurring within the country. Indeed, in the wake of the most severe outbreak of Ebola in history, HealthMap was widely cited and celebrated as the surveillance technology "that built the algorithm that spotted Ebola before the WHO did",[31] re-igniting once again intense global health security interest in how the real-time surveillance and detection of emergent disease risks could be accelerated through the blending and amalgamation of depth and surface knowledge generating practices.

At European health security levels, shifts to further integrate and combine the digital forecasting capacities of these surface knowledge systems with existing pillars of traditional surveillance approaches was also observed with the issuance of a joint report of the ECDC/European Commission JRC[32] in 2011, which called for new and extended collaborations to integrate the GPHIN and HealthMap systems as key epidemic intelligence suppliers to bolster and expand the reporting capacities of the Union's own MedISys system.

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28 C Freifeld at al, "HealthMap: Global Infectious Disease Monitoring through Automated Classification and Visualization of Internet Media Reports" (2008) 15(2) Journal of American Medical Informatics Association 150.

29 ibid.

30 Africaguinee.com <www.healthmap.org/ebola/#timeline>(last accessed 3 December 2019).

31 Newsweek <www.newsweek.com/algorithm-spotted-ebola-outbreak-9-days-who-announced-it-263875> (last accessed 3 December 2019).

32 Report on ECDC/JRC collaboration on development of online tool for epidemic intelligence <ecdc.europa.eu/en/news-events/report-ecdcjrc-collaboration-development-online-tool-epidemic-intelligence> (last accessed 3 December 2019).

4. Combining and operationalising surface knowledge in European health security

Understood collectively then, iterative processes of digitisation, the coming era of "Big Data" with its abundance of new data sources, and new surveillance operations of epidemic intelligence have enabled the novel practicing of European health surveillance operations which are now characterised by the blending and co-existence of systems of depth and surface knowledge acting jointly,[33] in the regulation of future epidemics and pandemics.

In epistemological terms, this pushing back of the data frontier, and the debut of European health security practices which process open-source data to accelerate outbreak detection have also re-situated the underlying constitution of what is considered and legitimised as *knowledge* in the assessment of emergent epidemics and pandemics. Here again, the work of Foucault and his analysis of the governing processes of European populations serves as a productive site of contrast in understanding how European epidemic intelligence practices and its production of digitised streams of surface knowledge differ from preceding systems and protocols of disease surveillance.

In his assessment of the emergence of population as a problem of government and knowledge in the 18th century,[34] Foucault illustrated how with the ascent of the European governmental state, the health and illness of populations was re-conceptualised as being "as of a priority for all, and the state of health of a population was a general objective of policy".[35] Subsequently, with the new understanding of the strategic value of the health of the population as an end of government, new knowledge-generating practices were launched to regulate and govern health variables within populations and these early public health surveillance operations sought to end recurrent epidemics, to reduce death-rates, and to extend the average life-span and life-expectancy of every age group.[36]

Central within Foucault's conceptualisation of population as a new object of surveillance and regulation within the governmental state were *depth* knowledge-generating practices, including clinical medicine, individual examination and diagnosis, epidemiology, biology and demography which focused on the production of knowledge for governing populations against the emergence of natural phenomena including epidemics. These health surveillance practices conducted within the early modern states of Europe extracted and produced data for the governing of epidemics from the "body"; the body of examined individuals, and the body of populations, both of which emerged as bearers of new variables between healthy and sick, strong and weak.[37] Within his *Security, Territory, Population* lecture series, Foucault further demonstrated how data extracted from such depth

33 Weir and Mykhalovskiy, supra, note 20.

34 M Foucault, *Power/Knowledge: Selected Interviews & Other Writings 1972–1977* (Vintage Publishing 1980).

35 ibid, pp 168–175.

36 ibid.

37 ibid.

knowledge practices were utilised in the surveillance and inoculation campaigns against epidemics of smallpox across Europe in the 18^{th} century.[38]

Contrastingly, the new data sources of potential epidemics and pandemics utilised by EU health security officials in the 21^{st} century expand the parameters for what constitutes legitimate data for the managing of public health emergencies. Unlike within preceding governmental systems, the heterogeneous data sources collated and assessed by way of European epidemic intelligence practices are open-sourced, non-medical in nature, and in many instances have not been clinically or scientifically verified or linked to confirmed cases. These data sources are alternatively valued for the speed at which they can be collected and assessed by technological processes, and for the situational awareness and additional detail and insight they may be able to add in situations where requisite epidemiological or clinical outbreak data may be lacking.

In the era of Big Data and global pandemic risk, health security logics of the EU have now alternatively sought to bolster and supplement these traditional disease surveillance processes by new recourses to the rapid production of surface knowledge signals and alerts produced from epidemic intelligence practices. Significantly, this shift towards a blended surveillance approach across EU levels which integrates depth and surface knowledge processes for the identification of European public health risks, further transforms and expands what type of data can be used in the assessment of disease forecasts. This now includes media reporting, social media feeds and content, online observations, eye-witness reporting, and crowd-sourced surveillance findings, all of which constitute strategic novel indicators of outbreak risks in an era of digital data abundancy.

V. On misfires, miscalculation and misinformation

This article has thus far traced how successive waves of digitisation of health infrastructures, and the production of diverse big data sources have enabled EU health security actors to practice accelerated modes of disease surveillance operations in the early 21^{st} century. Resulting from a strategic convergence of digital innovation and open-source data production, EU health security practitioners over the past two decades have demonstrated new instances of employing epidemic intelligence systems to supplement the surveillance of potential disease outbreaks, giving rise to a blended infectious disease surveillance approach across the EU which draws upon ranges of depth and surface knowledge configurations to preserve and ensure the EU's health security.

And yet, while these novel digitised epidemic intelligence technologies have been rapidly incorporated as core components in expanding EU health surveillance assemblages, and have been widely accredited for reporting successes of emergent public health emergencies ranging from SARS to Ebola to new strains of influenza, less critical attention has focused, for example, on how these emergent pandemic regulating technologies themselves require regulation from the health security

[38] Supra, note 7.

networks they are designed to support. Although these epidemic intelligence practices have been prized for their capacity to generate new digital surface alerts, the emergent and largely experimental nature of these digital surveillance methods also ushers forward variable margins of error which can – and have – produced misfires, miscalculations and misinformation stemming from technical breakdown to issues of data quality extracted from heterogeneous contexts.

Perhaps no other example is more infamous than the rise and subsequent demise of Google Flu Trends in discussing and highlighting the fragility and potential limitations of such big data surveillance approaches. While the open-source disease surveillance system was widely celebrated for its initial innovative approach to processing search-query data to track the spread of seasonal influenza ahead of traditional health surveillance institutes including the CDC across the United States in 2009, the surveillance platform failed only a few years following when it steeply over-estimated incidences of influenza during the 2013 season. This false reporting occurred when the Flu Trends algorithm failed to decipher between actual occurring cases of influenza with unexpected spikes in search queries during epidemics, driven by "media stoked panic", which Google later acknowledged had provoked Flu Trend's dramatic overestimation.[39]

This approach to processing big data, with little appreciation of the context or nuances which accompany the generation of such data, reveals serious operational issues which inform many epidemic intelligence systems. As Simonsen and colleagues[40] elsewhere have highlighted, disease-related search queries may capture a variety of signals unrelated to the occurrence of real infectious disease outbreaks. Without correctly implemented filters, data can be misleading, if not alarmist, or amusing; see for example when the Google general search tool revealed a reported cholera "epidemic" in the United States in 2007, as a result of Oprah Winfrey picking *Love in the Time of Cholera* as book of the month in the Oprah book club.[41] Within European health security contexts, issues in the day-to-day smooth running of these epidemic intelligence systems have also been noted, for instance when digital web-scanning technologies utilised by the ECDC routinely trigger outbreak alerts to on-duty officials every time a Swedish band called *Dengue* play a show.[42] While these illustrative examples offer much in understanding how the success of these epidemic intelligence practices are heavily contingent upon issues of variance and quality of the big data sets they survey, the potential for misfires, miscalculations and misinformation produced by these technologies has also given rise to new forms of regulation of these signals and alerts as a new central activity for EU health security practitioners.

To the present day, European health security practitioners have been successful in corralling the runaway impacts of these technologies through the tightly controlled

39 V Duclos, "Algorithmic futures: The life and death of Google Flu Trends" (2019) 6(3) Medicine Anthropology Theory 54.

40 Supra, note 8.

41 ibid.

42 L Bengtsson et al, "Assembling European health security and the hunt for cross-border health threats" (2019) 50(2) Security Dialogue 115.

validation of these issued signs and signals alongside established clinical, epidemiological and scientific reporting from EU Member States and global health partners. What is more, EU health security officials, in seeking to moderate the more celebratory claims of big data analysis in enhancing disease surveillance, have continually emphasised the supplemental nature and value of its integrated epidemic intelligence technologies, and how these emergent forms of surface knowledge generated alerts can support and complement the long-established disease surveillance systems of all EU Member States.[43]

VI. Conclusion

Situated within the new logics and practices which underpin the European governance of health crises and disaster management, this article has traced transformations occurring within European health security practices in an age of digital data abundancy and heightened EU pandemic vigilance. This article has demonstrated how, enabled by processes of digitisation and waves of "computerisation" occurring over the past half-century, the rise of the EU as both a regional and global health security arbiter has been bolstered and supported by recourses to new health surveillance practices and methods foregrounded in the accrual of more and more digital data from a variety of sources. By tracing these new EU shifts and approaches to utilising open-source data to "get ahead of the epidemic curve", this article has presented epidemic intelligence as a transformative surveillance practice, predicated on big data sources, which has been rapidly adopted and integrated by EU health security officials over the past two decades.

By drawing upon and unpacking the concept of digitised surface knowledge generation relating to the integration and operationalisation of these systems within EU health security frameworks, this article has further illustrated the conceptual divergences which occur in integrating new open-source data gathering practices for the accelerated detection of pandemic risks. Within the present health + security nexus of the EU, the surveillance and regulation of circulating pathogens is no longer the sole remit of the governmental European nation state, described by Foucault in his many lectures with its refined clinics, hospitals and statistical institutes as the exclusive curators and purveyors of medically, clinically and scientifically verified pandemic alerts and forecasting. In contrast, the centralisation of these new epidemic intelligence technologies to the core of contemporary EU health security operations in an era of pandemic risk and expanding "big data" has been foundational to the ascent of a new blended and evolving health surveillance approach and logic, which amalgamates the digitised surface alerts of these open-source systems with the long-established and traditional depth knowledge generating disease surveillance legacies of EU Member States.

However, in seeking to extend analysis beyond the novelty and adoption of these epidemic intelligence systems for European health security, this article has worked to draw focus towards the pitfalls of (big) data hubris in health surveillance contexts,

[43] Supra, note 17.

and to also emphasise the inherent messiness of such emergent technologies. While the incorporation of these new digital health surveillance techniques have indeed speeded up the detection of public health threats by bypassing traditional indicator-based surveillance structures,[44] their operations within EU health security frameworks continue to be tightly monitored and regulated for potential misfires which stem from data quality and evolving data-analytic processes, or what Martin French has elsewhere described as the digital "gaps in the gaze".[45]

Significantly, the composition of this article, which has examined the rise of new EU health security practices, was enabled by digitisation and data abundancy, and has occurred alongside an expanding and ongoing "big data" policy-fever across the EU. This is evidenced by the championing of new concepts including the digital single market and within public engagement campaigns for EU citizens 'What can big data do for you?'[46] Within these ongoing shifts towards harnessing more and more data for the accelerated identification of public health risks, the continued strengthening of EU health preparedness via evolving data collection methods shows little signs of yielding at the start of a new decade, illustrated for example by the European Commission's recent funding call (SC1-BHC-13-2019) as part of Horizon 2020's Work Programme: 'Mining Big Data for Early Detection of Infectious Disease Threats Driven By Climate Change and other Factors'.[47] In building upon the practices and logics established initially by the rise of European epidemic intelligence practices, the formidable challenge then for EU health security frameworks going forward in an era of advancing data-processing methods, and increasingly sensitive (big) data-sources,[48] will inevitably be the continued pairing of the gains afforded by these expanding digital disease surveillance processes with the need to consistently monitor and mitigate the potential impacts upon the security, privacy and human rights of EU citizens stemming from these evolving risk-regulating techniques.

[44] E Velasco et al, "Social Media and Internet-Based Data in Global Systems for Public Health Surveillance: A Systematic Review" (2014) 92(1) Milbank Quarterly 7.

[45] M French, "Gaps in the gaze: Informatic practice and the work of public health surveillance" (2014) 12(2) Surveillance & Society 226.

[46] European Commission, "What can big data do for you?" <ec.europa.eu/digital-single-market/en/what-big-data-can-do-you> (last accessed 3 December 2019).

[47] European Commission Horizon 2020 Work Programme 2018-2020 <ec.europa.eu/research/participants/data/ref/h2020/wp/2018-2020/main/h2020-wp1820-health_en.pdf> (last accessed 3 December 2019).

[48] In recent years, for example, there has been much discussion on how the linking of digitised electronic health records (EHRs) to person-specific pathogen genomic data could enhance the timeliness, precision and effectiveness of public health responses to infectious diseases. Within these new health surveillance practices, however, ongoing issues surrounding the possibility of re-identifying anonymised personal data continue to be of the highest ethical and legal concern. See further G Gilbert et al, "Communicable Disease Surveillance Ethics in the Age of Big Data and New Technology" (2019) 11(2) Asian Bioethics Review 173.