

# Developing a Multidisciplinary Syndromic Surveillance Academic Research Program in the United Kingdom: Benefits for Public Health Surveillance

Public Health Reports  
2017, Vol. 132(Supplement 1) 111S-115S  
© 2017, Association of Schools and  
Programs of Public Health  
All rights reserved.  
Reprints and permission:  
sagepub.com/journalsPermissions.nav  
DOI: 10.1177/0033354917706953  
journals.sagepub.com/home/phr



Alex J. Elliot, PhD<sup>1,2</sup>, Roger Morbey, MSc<sup>1,2</sup>, Obaghe Edeghere, MPH<sup>1,2</sup>,  
Iain R. Lake, PhD<sup>2,3</sup>, Felipe J. Colón-González, PhD<sup>2,3</sup>,  
Roberto Vivancos, MD<sup>4,5,6</sup>, G. James Rubin, PhD<sup>2,7</sup>,  
Sarah J. O'Brien, MBBS<sup>5,6</sup>, and Gillian E. Smith, MBBS<sup>1,2</sup>

## Keywords

syndromic surveillance, research, public health, collaboration, academic

Syndromic surveillance is growing in stature globally as a recognized and innovative approach to public health surveillance. Syndromic surveillance can be defined as the near-real-time collection, analysis, interpretation, and dissemination of health-related data to enable the early identification of the impact (or absence of impact) of potential health threats that may require public health action.<sup>1</sup> Public Health England (PHE) coordinates a real-time syndromic surveillance service across England and operates national syndromic surveillance systems from 4 sources: general practitioner (family physician) in-hours consultations, general practitioner out-of-hours consultations, sentinel emergency department visits reported to PHE's Emergency Department Syndromic Surveillance System, and calls to the National Health Service 111 nonemergency medical helpline.<sup>2-4</sup> PHE's syndromic surveillance service involves the collection, analysis, interpretation, and assessment of data on a daily basis. Data analysis uses epidemiologic methods and statistical algorithms incorporating a multilevel hierarchical mixed-effects model that compares contemporaneous data with historical data to identify excess activity.<sup>5</sup> Data are aggregated into syndromic indicators, based on symptoms and/or clinical diagnoses of disease (eg, diarrhea, acute respiratory infection). Trends and key public health messages are published in weekly bulletins.<sup>6</sup>

The underlying aims of this syndromic surveillance service are to provide early warning of seasonal increases of disease, situational awareness during incidents, and reassurance of a lack of impact of risks (particularly valuable during mass gatherings, such as the Olympic and Paralympic Games). Delivery of this service complements existing public health surveillance programs within PHE (eg, seasonal influenza surveillance).<sup>7</sup>

To ensure that a national syndromic surveillance service is underpinned by scientifically valid and rigorous methods,

it needs to be strongly linked to academia. A consistent and structured link between public health service activities and academia in the field of syndromic surveillance is lacking in the United Kingdom (UK). Often, good-quality syndromic surveillance research is undertaken in isolation in the academic setting, with the benefits of this research not shared with public health systems or put into practice. Likewise, academic research groups may not benefit from syndromic surveillance work undertaken by public health organizations.

Public health organizations can provide access to health-related data and expertise in infectious and noninfectious disease epidemiology and clinical interpretation of data. Academic research can optimize and develop methodological rigor and intellectual clarity and establish routes for

<sup>1</sup> Real-time Syndromic Surveillance Team, National Infection Service, Public Health England, Birmingham, United Kingdom

<sup>2</sup> Health Protection Research Unit in Emergency Preparedness and Response, National Institute for Health Research, London, United Kingdom

<sup>3</sup> School of Environmental Sciences, University of East Anglia, Norwich, United Kingdom

<sup>4</sup> Field Epidemiology Services, National Infection Service, Public Health England, Liverpool, United Kingdom

<sup>5</sup> Institute of Infection and Global Health, University of Liverpool, Liverpool, United Kingdom

<sup>6</sup> Health Protection Research Unit in Gastrointestinal Infections, National Institute for Health Research, Liverpool, United Kingdom

<sup>7</sup> Department of Psychological Medicine, King's College London, London, United Kingdom

## Corresponding Author:

Alex J. Elliot, PhD, Real-time Syndromic Surveillance Team, National Infection Service, Public Health England, 5 St Philips Pl, 6th Fl, Birmingham B3 2PW, United Kingdom.

Email: alex.elliott@phe.gov.uk

external research funding. Together, these specialist competencies can enhance the public health benefits of syndromic surveillance.

PHE has previously collaborated with academic partners on syndromic surveillance research projects; however, the approach to date has been reactive rather than proactive, waiting for calls of interest and then working with academic units on single disease subject areas instead of taking a collaborative approach. To address this issue, PHE is developing a partnership model that will bring together its syndromic surveillance program with academic collaborators to maximize the public health benefits of syndromic surveillance. This approach will integrate experts from various disciplines, including public health, medicine, informatics, epidemiology, statistics, modeling, and environmental health. In this commentary, we provide our vision for a multidisciplinary syndromic surveillance academic research program in England, make the case for this approach, and illustrate the progress that has been made toward achieving this goal.

### **Syndromic Surveillance in Academic Research Programs**

The UK National Institute for Health Research funds health care research, translating discoveries into practical products, treatments, devices, and procedures that involve patients and the public. In 2014, the institute established 13 Health Protection Research Units (HPRUs), following a 2012 open call inviting UK universities to enter into research partnerships with PHE in several priority areas of public health research.<sup>8</sup> The institute provided research funding for a 5-year period starting April 1, 2014. The HPRUs act as centers of excellence in multidisciplinary health protection research in England. Each HPRU focuses on a priority area of health protection (eg, gastrointestinal infections) and is underpinned by a research partnership between several universities and PHE. The role of the HPRUs is to help PHE deliver its objectives and functions to protect the public's health.

Public health incidents and emergencies often present as complex events, requiring multiple teams to coordinate efforts to protect people's health. The HPRU in Emergency Preparedness and Response brings together scientific experts to identify emergencies and determine how many people have been affected, what types of countermeasures may be needed, who is most vulnerable, and how to protect the physical and mental health of victims and emergency responders.<sup>9</sup> Syndromic surveillance plays an important role in this research. The HPRU in Emergency Preparedness and Response has dedicated an area of research to syndromic surveillance to (1) further quantify the ability of existing syndromic surveillance systems to detect new outbreaks of disease or covert incidents involving a chemical, biological, or radiological agent<sup>10</sup> and (2) assess whether new data linkages, novel statistical techniques (eg, Bayesian networks), or new data sources (eg, social media) can enhance this surveillance activity.

The immediate benefit of integrating academic experts with syndromic surveillance within the HPRU in Emergency Preparedness and Response is an improved understanding of the capabilities of the syndromic surveillance systems used by PHE. One important area of this research is developing public health scenarios to test the ability and timeliness of syndromic surveillance systems to detect a real incident or refute an intelligence-led false alarm about an incident. The knowledge generated from this work will enhance the ability of PHE to respond to future incidents and further strengthen messages of reassurance and early warning.

Syndromic surveillance also plays an important research role in other HPRUs. The value of syndromic surveillance data to test hypotheses and complement other scientific databases has attracted interest from additional HPRU research groups, which have used syndromic surveillance data for numerous projects. For example, in collaboration with the HPRU in Environmental Change and Health, the HPRU in Emergency Preparedness and Response has undertaken research on the impact of heat waves and air pollution on the health care-seeking behavior of the English population.<sup>11-13</sup> Additionally, it is collaborating with the HPRU in Gastrointestinal Infections, examining data on diarrhea and vomiting indicators from PHE syndromic surveillance systems to analyze socioeconomic inequalities in gastrointestinal infections in England. These research projects further highlight the variety of public health work that syndromic surveillance can support, encompassing infectious diseases and environmental factors (Table 1).

### **Developing a Central Syndromic Surveillance Academic Partnership**

To further integrate academic and public health research in England, PHE and the University of Liverpool are developing a central syndromic surveillance academic partnership that will build on relationships with experts in the fields of public health and epidemiology at the university. The vision of this partnership is to develop a syndromic surveillance center that will innovate real-time syndromic surveillance applied research and developments. The center will also fulfill several additional objectives:

- Integrating the unique syndromic surveillance system infrastructure and expertise of the PHE team with a strong academic partner who has the skills and knowledge to apply and translate science into public health practice
- Proactively leading research on syndromic surveillance with a clear public health purpose
- Integrating expertise and experience in attracting external funding to support syndromic surveillance research
- Increasing the scientific rigor of syndromic surveillance and ensuring translation into practice

**Table 1.** Syndromic surveillance academic research in Public Health England and the benefits applied to the public health system

Academic Research Area	Application and Integration to Public Health
Air pollution impact	<ul style="list-style-type: none"> <li>• Improved understanding of the impact of air pollution incidents on health</li> <li>• Knowledge applied during incidents to provide reassurance of which indicators were used, their sensitivity, and the development of baselines used for surveillance during air pollution incidents<sup>11</sup></li> </ul>
Heat wave morbidity indicators	<ul style="list-style-type: none"> <li>• Improved knowledge of the impact of extreme heat on a wide range of morbidity indicators</li> <li>• Strengthened heat wave surveillance and improved reassurance to public health incident teams about which indicators are important for surveillance during heat waves<sup>12</sup></li> </ul>
Heat wave impact	<ul style="list-style-type: none"> <li>• Understanding the impact of heat waves with indicators of heat and sunstroke</li> <li>• Reassurance of sensitivity of indicators and development of baselines used for routine heat wave surveillance<sup>13</sup></li> </ul>
Incident scenarios	<ul style="list-style-type: none"> <li>• Understanding the characteristics of public health incidents (eg, pandemic influenza, <i>Cryptosporidium</i> contamination of the drinking water supply) that can be identified with syndromic surveillance indicators</li> <li>• Improved reassurance during outbreaks or incidents about what syndromic surveillance can detect</li> </ul>
Union of European Football Associations 2016 football tournament: impact on health, including cardiovascular events	<ul style="list-style-type: none"> <li>• Planning for future mass-gathering sporting events</li> <li>• Determining the public health impact of mass-gathering sporting events and updating guidance on which syndromic indicators should be routinely monitored during mass gatherings</li> </ul>
Impact of media reporting on syndromic surveillance	<ul style="list-style-type: none"> <li>• Understanding the possible impact of media coverage on syndromic surveillance data and the bias that it can introduce to data analysis and statistics</li> <li>• Improved interpretation of key messages during public health incidents and clear recommendations to incident directors<sup>15</sup></li> </ul>
Gastrointestinal infections	<ul style="list-style-type: none"> <li>• Improved understanding of the use of syndromic surveillance to detect local gastrointestinal outbreaks</li> <li>• Improved reassurance during incidents (eg, flooding) of what syndromic surveillance can detect</li> </ul>

- Ensuring a focus on the underlying methods of syndromic surveillance across all indicators and diseases
- Staying at the cutting edge of new syndromic surveillance developments, including data sources, methods, horizon scanning, and technology
- Providing continual evidence of demonstrable public health impact

A strategy written to achieve these objectives outlines the aims of the collaboration and presents the short-, medium-, and long-term deliverables (Table 2). The sample deliverables illustrate an innovative approach to integrating academic research into syndromic surveillance public health programs. The approach taken in England has already contributed to several demonstrable benefits to the public health system, including joint publications<sup>14,15</sup> and 2 doctor of philosophy (PhD) studentships. These benefits are expected to increase as the collaboration matures.

Establishing such proposed partnerships can be beneficial but also challenging. In the fields of public health and academia, workloads are increasing because of reduced funding; therefore, finding the resources required to establish such

partnerships, including developing strategies, terms of reference, and management groups, can be difficult. It is therefore essential that such partnerships are based on a genuine desire to collaborate rather than on business or contractual obligations.

### Future Implications for Public Health

The vision and developments described in this commentary are the first steps toward the goal of integrating syndromic surveillance-related activities and academic research in England. The benefits and application of research findings to the PHE syndromic surveillance system have been shown; however, the next few years will determine the program's overall success. Further expansion of the research agenda, developing a PhD and postdoctoral training program, and generating external funding to support research are all achievable medium- and long-term goals. PhD and postdoctoral researchers will integrate into the public health system, not just gaining access to syndromic surveillance data for research, but also learning core public health skills and

**Table 2.** Examples of short-, medium-, and long-term objectives and expected outcomes of the syndromic surveillance academic partnership between PHE and the University of Liverpool, 2015-2020

Objectives	Outcomes
<b>Short term (12-24 mo)</b>	
Memorandum of understanding between parties	Agreed-on collaborative principles and terms of reference for collaboration
Steering group to direct the collaboration	Project guidance from a range of experts
Honorary academic appointments for PHE syndromic surveillance staff members	Professional development; improved capacity for the university
PhD studentship program	Training of future PHE specialists; improved capacity for PHE
Collaborative peer-review publications	Increased reputation and evidence base for syndromic surveillance
<b>Medium term (2-4 y)</b>	
Completed PhD degrees and ongoing program of PhDs	Increased capacity for PHE and the university
Regular syndromic surveillance scientific meetings and seminar program	Dissemination of latest developments in the syndromic surveillance academic partnership
<b>Long term (<math>\geq 5</math> y)</b>	
Syndromic surveillance training program for public health trainees	Increasing awareness of syndromic surveillance, integration into the public health training scheme, and local health protection
Center for syndromic surveillance excellence attracting international placements	Enhanced organizational reputation; international collaboration and coordination of projects

Abbreviations: PhD, doctor of philosophy; PHE, Public Health England.

competencies and contributing to the delivery of syndromic surveillance service.

Another potential development is the establishment of international collaborations to share expertise and resources on a global stage, particularly in countries with limited resources and where health care services do not support syndromic surveillance. The recent European Commission-funded Triple-S project consisted of an inventory of syndromic surveillance systems across Europe to identify key experts and survey the characteristics of established, pilot, expired, and planned systems.<sup>1</sup> Ultimately, building on Triple-S by developing a network of syndromic surveillance centers across Europe could be an achievable aim, with national centers for syndromic surveillance excellence coordinating a unified approach to syndromic surveillance. Other examples of syndromic surveillance collaboration can be found internationally. For example, the International Society

for Disease Surveillance has established a program for coordinating collaboration among syndromic surveillance experts who may not typically interact but who, when brought together, can enable innovative approaches to public health problems and develop solutions that would otherwise not be possible without this collaboration.<sup>16</sup> This program has led to a number of collaborative projects and outputs, including the development of forecasting models for infectious diseases and asthma.<sup>17</sup>

Although syndromic surveillance continues to be an integral part of the PHE surveillance program, the multidisciplinary syndromic surveillance academic research program discussed here will improve the usefulness of this surveillance nationally and lead to better international collaboration and knowledge sharing, ensuring that syndromic surveillance enhances public health surveillance programs across the globe.

### Acknowledgments

We thank the PHE Real-time Syndromic Surveillance Team for its scientific and technical excellence and support in maintaining the syndromic surveillance service.

### Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

### Funding

The authors disclosed receipt of the following financial support for the research, authorship, and/or publication of this article. This commentary was funded by the National Institute for Health Research's Health Protection Research Unit in Emergency Preparedness and Response at King's College London in partnership with Public Health England. The views expressed are those of the authors and not necessarily those of the National Health Service, the National Institute for Health Research, the Department of Health, or Public Health England.

### References

1. Triple S Project. Assessment of syndromic surveillance in Europe. *Lancet*. 2011;378(9806):1833-1834.
2. Elliot AJ, Hughes HE, Hughes TC, et al. Establishing an emergency department syndromic surveillance system to support the London 2012 Olympic and Paralympic Games. *Emerg Med J*. 2012;29(12):954-960.
3. Elliot AJ, Morbey RA, Hughes HE, et al. Syndromic surveillance—a public health legacy of the London 2012 Olympic and Paralympic Games. *Public Health*. 2013;127(8):777-781.
4. Harcourt SE, Morbey RA, Loveridge P, et al. Developing and validating a new national remote health advice syndromic surveillance system in England. *J Public Health (Oxf)*. 2017; 39(1):184-192.
5. Morbey RA, Elliot AJ, Charlett A, et al. The application of a novel “rising activity, multi-level mixed effects, indicator emphasis” (RAMMIE) method for syndromic surveillance in England. *Bioinformatics*. 2015;31(22):3660-3665.

6. Public Health England. Syndromic surveillance: systems and analyses. <https://www.gov.uk/government/collections/syndromic-surveillance-systems-and-analyses>. Accessed April 7, 2016.
7. Public Health England. Surveillance of influenza and other respiratory viruses in the United Kingdom: winter 2015 to 2016. [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/526405/Flu\\_Annual\\_Report\\_2015\\_2016.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/526405/Flu_Annual_Report_2015_2016.pdf). Published 2016. Accessed June 22, 2016.
8. National Institute for Health Research. Health Protection Research Units. <http://www.nihr.ac.uk/about-us/how-we-are-managed/our-structure/research/health-protection-research-units.htm>. Accessed February 28, 2017.
9. National Institute for Health Research. Health protection research unit in emergency preparedness and response. <http://epr.hpru.nihr.ac.uk>. Accessed June 22, 2016.
10. National Institute for Health Research, Health Protection Research Unit in Emergency Preparedness and Response. Our research, theme 3: enhancing syndromic surveillance for early detection of incidents. <http://epr.hpru.nihr.ac.uk/our-research/research-themes/theme-3-enhancing-syndromic-surveillance-early-detection-incident>. Accessed June 22, 2016.
11. Elliot AJ, Smith S, Dobney A, et al. Monitoring the effect of air pollution episodes on health care consultations and ambulance call-outs in England during March/April 2014: a retrospective observational analysis. *Environ Pollut*. 2016;214:903-911.
12. Smith S, Elliot AJ, Hajat S, et al. The impact of heatwaves on community morbidity and healthcare usage: a retrospective observational study using real-time syndromic surveillance. *Int J Environ Res Public Health*. 2016;13(1):pii:e132.
13. Smith S, Elliot AJ, Hajat S, et al. Estimating the burden of heat illness in England during the 2013 summer heatwave using syndromic surveillance. *J Epidemiol Community Health*. 2016;70(5):459-465.
14. Bawa Z, Elliot AJ, Morbey RA, et al. Assessing the likely impact of a rotavirus vaccination program in England: the contribution of syndromic surveillance. *Clin Infect Dis*. 2015; 61(1):77-85.
15. Elliot AJ, Hughes HE, Astbury J, et al. The potential impact of media reporting in syndromic surveillance: an example using a possible *Cryptosporidium* exposure in North West England, August to September, 2015. *Euro Surveill*. 2016;21(41):pii:30368.
16. International Society for Disease Surveillance. Workgroups: analytic solutions. <http://www.syndromic.org/cop/analytic-solutions>. Accessed December 8, 2016.
17. Reid M, Gunn J, Shah S, et al. Cross-disciplinary consultancy to enhance predictions of asthma exacerbation risk in Boston. *Online J Public Health Inform*. 2016;8(3):e199.