

1 **Developing a multidisciplinary syndromic surveillance academic research**
2 **programme in the United Kingdom: benefits for public health surveillance**

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20 **Abstract**

21 Syndromic surveillance is growing in stature internationally as a recognised and innovative
22 approach to public health surveillance. Syndromic surveillance research uses data captured by
23 syndromic surveillance systems to investigate specific hypotheses or questions. However, this
24 research is often undertaken either within established public health organisations or the
25 academic setting, but often not together. Public health organisations can provide access to
26 health-related data and expertise in infectious and non-infectious disease epidemiology and
27 clinical interpretation of data. Academic institutions can optimise methodological rigour,
28 intellectual clarity and establish routes for applying to external research funding bodies to
29 attract money to fund projects. Together, these competencies can complement each other to
30 enhance the public health benefits of syndromic surveillance research. This paper describes
31 the development of a multidisciplinary syndromic surveillance academic research programme
32 in England, United Kingdom, its aims, goals and benefits to public health.

33 **Background**

34 Syndromic surveillance is the near real-time collection, analysis, interpretation and
35 dissemination of health-related data to enable the early identification of the impact (or
36 absence of impact) of potential health threats which may require public health action.¹ Public
37 Health England (PHE) coordinates a programme of real-time syndromic surveillance across
38 England and operates four national syndromic surveillance systems: general practitioner
39 (family physician) in hours (GPIH) and general practitioner out of hours (GPOOH)
40 consultations, sentinel emergency department attendances (EDSSS) and calls to a national
41 telephone health line (NHS 111).²⁻⁴ Data are collected, analysed, interpreted and assessed on
42 a daily basis using statistical algorithms incorporating a multi-level hierarchical mixed effects
43 model that compares contemporaneous data to historical data to identify statistically
44 significant excess activity.⁵ Data are aggregated into ‘syndromic indicators’ based upon
45 symptoms and/or clinical diagnosis of disease (e.g. diarrhoea, acute respiratory infection),
46 and trends and key public health messages are published on a weekly basis.⁶

47 The underlying aims of this service are to provide: early warning of seasonal increases of
48 disease; situational awareness during incidents; and reassurance of a lack of impact of
49 specific risks (particularly valuable during mass gatherings such as the Olympic and
50 Paralympic Games). Delivery of this service complements existing public health surveillance
51 programmes within PHE (e.g. seasonal influenza surveillance).⁷

52 In order that a national syndromic surveillance service is underpinned by scientifically valid
53 and rigorous methods, it is important to ensure that there is a strong link with academia.

54 Within the field of syndromic surveillance there is often an absence of a consistent and
55 structured link between public health service activities and academia. Often, good quality
56 syndromic surveillance research is undertaken in isolation in the academic setting with the
57 benefits of this research not being translated into public health systems and practice.

58 Likewise, syndromic surveillance service work within the public health setting can be
59 isolated from the potential benefits of linking with academic research groups. Public health
60 organisations can provide access to health-related data and expertise in infectious and non-
61 infectious disease epidemiology and clinical interpretation of data. Academic research can
62 optimise and further develop methodological rigour, intellectual clarity and establish routes
63 for applying to external research funding bodies to attract money to fund projects. Together,

64 these specialist competencies can complement each other to enhance the public health
65 benefits of syndromic surveillance.

66 PHE have previously undertaken numerous academic collaborations on specific syndromic
67 surveillance research projects, however this approach to date has been reactive, waiting for
68 calls of interest and then working with individual academic units on single disease subject
69 areas. To address this issue and bring public health and academic expertise closer together,
70 PHE are currently developing a model of academic partnership working, bringing together
71 the PHE syndromic surveillance programme with a number of academic collaborators to
72 maximise the public health benefits of syndromic surveillance. The structure and benefits of
73 this approach are discussed in this paper.

74 **Current PHE syndromic surveillance academic research programmes**

75 *Health Protection Research Units*

76 The National Institute for Health Research (NIHR) is funded through the Department of
77 Health to improve the health and wealth of the nation through research. During 2014, thirteen
78 Health Protection Research Units (HPRUs) were established following an open competition
79 launched in 2012.⁸ The HPRUs act as centres of excellence in multidisciplinary health
80 protection research in England. Each HPRU focuses on a priority area of health protection
81 (e.g. gastrointestinal infections) and is underpinned by a research partnership between a
82 number of universities and PHE. The role of the HPRUs is to support PHE in delivering its
83 objectives and functions for the protection of the public's health. Research funding was
84 provided for a five-year period starting 1 April 2014.

85 Public health incidents and emergencies often present as complex events, requiring different
86 teams to co-ordinate their efforts in order to protect people's health. The HPRU in
87 Emergency Preparedness and Response (EPR) brings together groups of scientific experts to
88 allow the identification of emergencies, determine how many people have been affected,
89 what types of countermeasures may be needed, who is most vulnerable and how to protect the
90 physical and mental health of victims and emergency responders.⁹ Syndromic surveillance
91 plays an important role in this research and a research 'theme' within the EPR HPRU has
92 been dedicated to quantifying the ability of existing syndromic surveillance systems to detect
93 new outbreaks of disease or covert incidents involving a chemical, biological or radiological
94 agent.¹⁰ This theme also aims to assess whether new data links or novel statistical techniques

95 (e.g. Bayesian Networks), or the inclusion of new data sources (e.g. social media) can
96 enhance this surveillance activity.

97 The immediate benefit of the close integration of academic experts with syndromic
98 surveillance within the EPR HPRU is an improved understanding of the capabilities of the
99 syndromic surveillance systems used by PHE. One important area of research is the
100 development of a series of public health scenarios. These will test and compare the ability
101 and timeliness of specific syndromic surveillance systems to detect a real incident or refute an
102 intelligence-led false alarm about an incident. The knowledge generated from this work will
103 enhance the ability of PHE to respond to future incidents, and further strengthen messages of
104 reassurance and early warning.

105 Syndromic surveillance also plays an important research role in other NIHR HPRUs. The
106 value of syndromic data for testing hypotheses and complementing other scientific databases
107 has attracted interest from additional HPRU research groups, and syndromic data have been
108 utilised in a number of projects. Research on the impact of heatwaves, (including the use of
109 both specific and general morbidity indicators of heat impact) and air pollution on the
110 healthcare seeking behaviour of the population of England has been undertaken in
111 collaboration with the HPRU in Environmental Change and Health.¹¹⁻¹³ Diarrhoea and
112 vomiting indicators from PHE syndromic surveillance systems are currently being explored
113 for use in analysing socioeconomic inequalities in gastrointestinal infections in England
114 (HPRU in Gastrointestinal Infections). These research projects also further highlight the wide
115 variety of public health work that syndromic surveillance can support, encompassing
116 infectious diseases and environmental factors.

117 Successes from this partnership are already beginning to appear (Table 1). In particular, the
118 2015 possible *Cryptosporidium* exposure in the North West of England is a case in point
119 where public health, epidemiology and academic experts collaborated to explore the potential
120 impact of media reporting in syndromic surveillance during this incident (Elliot et al. 2016,
121 manuscript under review).

122 *Developing a central syndromic surveillance academic partnership*

123 To further integrate academic and public health research in England, a central syndromic
124 surveillance academic partnership is being developed between PHE and the University of
125 Liverpool, building on a foundation of established close links with experts in the fields of
126 public health and epidemiology at the University of Liverpool. The vision of this partnership

127 is to develop a syndromic surveillance ‘Centre’ that becomes an innovator in real-time
128 syndromic surveillance applied research and is at the leading edge of developments for
129 syndromic surveillance. The development of this Centre will also fulfil a number of further
130 objectives including:

- 131 • the integration of the unique syndromic surveillance system infrastructures and
132 service expertise of the PHE syndromic surveillance team with a strong academic
133 partner with skills and knowledge of application and translation into public health
134 practice;
- 135 • proactively leading research on syndromic surveillance with a clear public health
136 purpose;
- 137 • integrating expertise in attracting external funding to support syndromic surveillance
138 research;
- 139 • increasing the scientific rigour of syndromic surveillance and ensuring translation into
140 practice;
- 141 • ensuring a focus on the underlying methodologies of syndromic surveillance across
142 all indicators/diseases;
- 143 • staying at the cutting edge of new syndromic surveillance developments including
144 data sources, methodologies and technology;
- 145 • providing continual evidence of demonstrable public health impact.

146 In order to achieve these objectives, a strategy outline the aims of the collaboration and
147 presents the short, medium and long term deliverables (Table 2). The example deliverables
148 illustrate an innovative approach to integrating academic research into syndromic
149 surveillance public health programmes. The approach taken in England has already
150 contributed to a number of demonstrable benefits to the public health system, and it is
151 anticipated that these benefits will expand as the collaboration matures (Table 2).

152 **The future**

153 The developments described in this paper are the primary steps towards the goal of
154 integrating syndromic surveillance service related activities and academic research. The
155 benefits and application of research findings to the PHE syndromic surveillance service are
156 already demonstrable, however the next years will determine the overall success of this
157 programme. Further expansion of the research agenda, developing a PhD and postdoctoral
158 training programme and generating external funding to support research are all achievable

159 medium and long term goals. Another potential development is the establishment of
160 international collaborations to share expertise and resource, particularly in countries with
161 limited resources and where healthcare services do not support syndromic surveillance.
162 Ultimately, building on the recent European Commission-funded Triple-S project,¹
163 developing a network of syndromic surveillance centres across Europe could be an
164 achievable target, with ‘National Centres for Syndromic Surveillance Excellence’
165 coordinating a harmonized approach to syndromic surveillance.

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222 **Table 1: syndromic surveillance academic research within Public Health England and**
 223 **the benefits applied to the public health system**

Academic research area	Potential public health benefits	Application/integration into public health	Reference
Heat/sun stroke indicators	Understanding of impact of heat during heatwaves	Reassurance of sensitivity of indicators and baselines used for routine heatwave surveillance	¹³
Heatwave morbidity indicators	Knowledge of wider range of morbidity indicators useful for routine surveillance of heat	Reassurance to public health incident teams about indicators which are important for surveillance during heatwaves	¹²
Air pollution impact	Further knowledge of the impact of air pollution incidents on health	Reassurance of sensitivity of indicators and baselines used for surveillance during air pollution incidents	¹¹
Incident scenarios	Understanding of the characteristics of a range of public health incidents that can be identified using syndromic surveillance indicators	Improved reassurance during outbreaks or incidents about what syndromic surveillance can detect	(Colon-Gonzalez et al. In preparation)
UEFA Euro 2016 impact on health, including cardiovascular events	Planning for future mass gathering sports events	Guidance on which syndromic indicators should be routinely monitored during mass gatherings	(Hughes et al. In preparation)
Impact of media reporting on syndromic surveillance	Understanding of the possible impact of media coverage on syndromic surveillance data and bias this can introduce to	Improved interpretation of key messages during public health incidents and clear recommendations to incident directors	Elliot et al. Submitted for publication.)

	data analysis/statistics		
Gastrointestinal infections	Improved understanding of utility of syndromic surveillance detecting local GI outbreaks	Improved reassurance during incidents e.g. flooding of what syndromic surveillance can detect	(Work in progress)

225 **Table 2: Examples of short, medium and long term deliverables from the syndromic**
 226 **surveillance academic partnership between Public Health England and the**
 227 **University of Liverpool**

Short term objectives (12-24 months)	Medium term objectives (2-4 years)	Long term objectives (5+ years)
Memorandum of understanding between parties	Completed PhDs and ongoing programme of PhDs	Syndromic surveillance training programme for public health trainees
Establish a steering group to direct the collaboration	Regular syndromic surveillance scientific meetings/seminar programme	Centre for syndromic surveillance excellence attracting international placements
Honorary academic appointments for PHE syndromic surveillance staff	Jointly led research funding bids to attract funding to support research	
PhD studentship programme		
Collaborative peer review publications		

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