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Post-pandemic development of sentinel surveillance of respiratory disease, in the context of the WHO mosaic framework: protocol for the English primary care network 2023-2024

Xinchun Gu, Conall Watson, Utkarsh Agrawal, Heather Whitaker, William Hamilton Elson, Sneha Anand, Ray Borrow, Anna Buckingham, Elizabeth Button, Lottie Curtis, Dominic Dunn, Alex Elliot, Filipa Ferreira, Rosalind Goudie, Uy Hoang, Katja Hoschler, Gavin Jamie, Debasish Kar, Beatrix Kele, Meredith Leston, Ezra Linley, Jack Macartney, Gemma L Marsden, Cecilia Okusi, Omid Parvizi, Catherine Quinot, Praveen Sebastian Pillai, Vanashree Sexton, Gillian Smith, Timea Suli, Nick Thomas, Catherine Thompson, Daniel Todkill, Rashmi Wimalaratna, Matthew Inada-Kim, Nick Andrews, Victoria Tzortziou-Brown, Rachel Byford, Maria Zambon, Jamie Lopez-Bernal, Simon de Lusignan

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Xinchun Gu[1*] PhD; Conall Watson[2*] PhD; Utkarsh Agrawal[1*] PhD; Heather Whitaker[3*] PhD; William Hamilton Elson[1*] MBBS, MSc; Sneha Anand[1] PhD; Ray Borrow[4] PhD; Anna Buckingham[5] BMedSci, BMBS, MRCP; Elizabeth Button[1] MSc; Lottie Curtis[6] MSc; Dominic Dunn[1]; Alex Elliot[7] PhD; Filipa Ferreira[1] PhD; Rosalind Goudie[1*] MSc; Uy Hoang[1] BSc, MBBS, MPH, MD; Katja Hoschler[8] PhD; Gavin Jamie[1] MSc; Debasish Kar[1] MSc; Beatrix Kele[8] PhD; Meredith Leston[1] MSc; Ezra Linley[4] PhD; Jack Macartney[1]; Gemma L Marsden[6] BSc, MSc, PhD; Cecilia Okusi[1] MRES; Omid Parvizi[1, 8] PhD; Catherine Quinot[9] PhD; Praveen Sebastian Pillai[10]; Vanashree Sexton[1] PhD; Gillian Smith[7] MBBS; Timea Suli[1] PhD; Nick Thomas[6] BSc, PhD; Catherine Thompson[8] PhD; Daniel Todkill[7] MBChB; Rashmi Wimalaratna[1] BSc, MBBS; Matthew Inada-Kim[5] MBBS; Nick Andrews[11] PhD; Victoria Tzortziou-Brown[6] PhD; Rachel Byford[1] BA; Maria Zambon[10] PhD; Jamie Lopez-Bernal[2] PhD; Simon de Lusignan[1] MSc, MD, FBCS, CITP, FFCI, FRCGP

[1]Nuffield Department of Primary Care Health Sciences University of Oxford Oxford GB
[2]Immunisation and Vaccine-Preventable Diseases Division UK Health Security Agency London GB
[3]Statistics, Modelling and Economics Department UK Health Security Agency London GB
[4]Vaccine Evaluation Unit UK Health Security Agency Manchester GB
[5]NHS England London GB
[6]Royal College of General Practitioners London GB
[7]Real-time Syndromic Surveillance Team UK Health Security Agency London GB
[8]Respiratory Virus Unit UK Health Security Agency London GB
[9]UK Health Security Agency London GB
[10]Virus Reference Laboratory UK Health Security Agency London GB
[11]Immunisation Division UK Health Security Agency London GB
[*]these authors contributed equally

Corresponding Author:
Simon de Lusignan MSc, MD, FBCS, CITP, FFCI, FRCGP
Nuffield Department of Primary Care Health Sciences
University of Oxford
Radcliffe Primary Care Building, Radcliffe Observatory Quarter
Woodstock Rd
Oxford
GB

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Abstract

Background: Pre-pandemic sentinel surveillance was orientated towards improved management of winter pressures, with influenza-like illness (ILI) the key clinical indicator. Recently the World Health Organisation (WHO) has published global standards for influenza surveillance, which include monitoring acute respiratory infection (ARI) as well as ILI. The WHO's mosaic framework recommends countries' surveillance strategies include the virological monitoring of influenza, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), respiratory syncytial virus (RSV) and other viruses with pandemic potential. The Oxford-Royal College of General Practitioner (RCGP) Research and Surveillance Centre (RSC) in collaboration with the UK Health Security Agency (UKHSA), has provided sentinel surveillance since 1967 including virology since 1993.

Objective: To describe the RSC's plans for sentinel surveillance in the 2023-2024 season and evaluate these plans against the WHO mosaic framework.

Methods: Our approach, which includes patient and public involvement (PPI), contributes to surveillance objectives across all three domains of the mosaic framework.

We will generate an ARI phenotype to enable reporting this indicator in addition to ILI. These data will support sentinel surveillance including vaccine effectiveness (VE) and burden of disease studies as well as UKHSA's sentinel surveillance. The panel of virology tests analysed in UKHSA's reference laboratory will remain unchanged, with additional plans for point-of-care testing (POCT), testing for pneumococcus and for screening asymptomatic individuals. Our new sampling framework for serological surveillance will provide greater representativeness and more samples from younger people. We will create a biomedical resource that enables linkage between clinical data held in the RSC with virology data including sequencing data held by UKHSA. We describe the governance framework for the RSC.

Results: We are co-designing our communication about data sharing and sampling, contextualised by the mosaic framework, with national and general practice PPI groups.
We present our ARI digital phenotype and key data we request RSC network members record in computerised medical record (CMR). We will share data with UKHSA to report VE for COVID-19 and influenza, and the disease burden of RSV, as well as for syndromic surveillance.
Virological surveillance will include COVID-19, influenza, RSV and other common respiratory viruses. We plan to pilot POCT for group A Streptococcus, urine tests for pneumococcus and asymptomatic testing. We will integrate test requests and results with the laboratory-CMR systems. A biomedical resource will enable research linking clinical to virology data including viral sequencing.
The legal basis for the RSC's pseudonymised data extract is The Health Service (Control of Patient Information) Regulations 2002, all non-surveillance uses require research ethical approval.

Conclusions: The RSC's extended its surveillance activities to meet more, but not all the mosaic framework's objectives. We have introduced an ARI indicator, seek to improve our responsiveness, but could do more around transmissibility, and benefit-risk of non-vaccine therapies.

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Original Paper

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Authors

First authors in order of contribution from:

Xinchun Gu, PhD, Researcher, Oxford University, xinchun.gu@phc.ox.ac.uk, ORCID - 0000-0002-2202-6792

Conall Watson, PhD, Consultant Epidemiologist, Immunisation and Vaccine-Preventable Diseases Division, UKHSA, conall.watson@ukhsa.gov.uk, ORCID - 0000-0002-2469-791X

Utkarsh Agrawal, PhD, Research Fellow, Oxford University, utkarsh.agrawal@phc.ox.ac.uk, ORCID - 0000-0001-5181-6120

Heather Whitaker, PhD, Senior Statistician, Statistics, Modelling and Economics Department, UKHSA, heather.whtiaker@ukhsa.gov.uk, ORCID - 0000-0001-5833-1863

William Hamilton Elson, MBBS, MSc, Clinical Doctoral Fellow, Oxford University, william.elson@phc.ox.ac.uk, ORCID - 0000-0002-8630-1378

Other contributors alphabetically

Sneha Anand, PhD, Project Manager, Oxford University, sneha.anand@phc.ox.ac.uk, ORCID - 0000-0002-0538-3974

Ray Borrow, Consultant Clinical Scientist, Vaccine Evaluation Unit, UK Health Security Agency, ray.borrow@ukhsa.gov.uk, ORCID - 0000-0002-0691-6568

Anna Buckingham, BMedSci, BMBS, National Medical Director's Clinical Fellow, NHS England, annabuckingham2@nhs.net, ORCID - 0009-0005-0049-9627

Elizabeth Button, MSc, Practice Liaison Officer and Research Facilitator, Oxford University, elizabeth.button@phc.ox.ac.uk, ORCID- 0000-0003-0777-2508

Lottie Curtis, BSc MSc, Research Projects and Communications Officer, Royal College of General Practitioners, Lottie.Curtis@rcgp.org.uk, (no ORCID iD)

Dominic Dunn, Project Manager, Oxford University, Dominic.Dunn@phc.ox.ac.uk, ORCID – 0009-0009-6752-6238

Alex Elliot, PhD, Consultant Epidemiologist, UKHSA, Real-time Syndromic Surveillance Team, Alex.Elliot@ukhsa.gov.uk, ORCID - 0000-0002-6414-3065

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Filipa Ferreira, PhD, Senior Project Manager, Oxford University, filipa.ferreira@phc.ox.ac.uk, ORCID - 0000-0003-0083-4809

Rosalind Goudie, SQL Developer, Oxford University, rosalind.goudie@phc.ox.ac.uk, ORCID - 0000-0002-4786-3394

Uy Hoang, BSc, MBBS, MPH, MD(Res), Research Fellow, Oxford University, uy.hoang@phc.ox.ac.uk, ORCID - 0000-0002-8428-5140

Katja Hoschler, PhD, Deputy Head of Respiratory Virus Unit, Respiratory Virus Unit, UKHSA, katja.hoschler@ukhsa.gov.uk, ORCID - 0000-0003-4837-0433

Gavin Jamie, MSc, Clinical Researcher, Oxford University, (1) gavin.jamie@phc.ox.ac.uk, (2) @qofdatabase, ORCID - 0000-0001-9147-7784

Debasish Kar, MSc, GP academic, Oxford University, debasish.kar@phc.ox.ac.uk, ORCID - 0000-0002-1524-1312

Beatrix Kele, PhD, Clinical Scientist, Respiratory Virus Unit, UKHSA, Beatrix.Kele@ukhsa.gov.uk, ORCID - 0000-0003-1273-7299

Meredith Leston, MSc, MRC iCASE Doctoral Fellow, Oxford University, meredith.leston@linacre.ox.ac.uk, ORCID - 0000-0003-0891-714X

Ezra Linley, PhD, Deputy Head of Vaccine Evaluation Unit, Vaccine Evaluation Unit, UKHSA, ezra.linley@ukhsa.gov.uk, ORCID - 0000-0002-5935-6154

Jack Macartney, Practice Liaison Officer and Research Facilitator, Oxford University, jack.macartney@phc.ox.ac.uk, ORCID- 0000-0003-0678-2659

Gemma L Marsden, BSc MSc PhD, RCGP, Head of Research and Innovation, Royal College of General Practitioners, Gemma.Marsden@rcgp.org.uk, ORCID - 0000-0001-8710-1071

Cecilia Okusi, MRes, SQL Developer and Data Scientist, Oxford University, cecilia.okusi@phc.ox.ac.uk, ORCID - 0000-0002-5575-8527

Omid Parvizi, PhD, Senior Data Analyst, (1) Oxford University, (2) Respiratory Virus Unit, UKHSA, omid.parvizi@phc.ox.ac.uk, ORCID - 0000-0003-4654-6909

Catherine Quinot, PhD, Senior scientist (Epidemiology), UKHSA, catherine.quinot@ukhsa.gov.uk, ORCID - 0009-0002-5634-7073

Praveen Sebastian Pillai, Head of Scientific Information Services, Virus Reference Laboratory, UKHSA, Praveen.Sebastianpillai@ukhsa.gov.uk, ORCID - 0009-0004-1361-3401

Vanashree Sexton, PhD, Practice Liaison Officer, Oxford University, vanashree.sexton@phc.ox.ac.uk, ORCID - 0000-0002-6935-016X

Gillian Smith, MBBS, Consultant Epidemiologist, UKHSA Real-time Syndromic Surveillance Team, Gillian.Smith@ukhsa.gov.uk, ORCID 0000-0002-4257-0568

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Timea Suli, PhD, Practice Liaison Officer, Oxford University, timea.suli@phc.ox.ac.uk, ORCID - 0009-0009-6982-3180

Nick Thomas, BSc, PhD, MBBS, Clinical Research Lead, Royal College of General Practitioners, nicholas.thomas@rcgp.org.uk, ORCID - 0000-0003-0460-6870

Catherine Thompson, PhD, Clinical Scientist, Respiratory Virus Unit, UKHSA, Catherine.Thompson@ukhsa.gov.uk, ORCID - 0000-0003-4895-2791

Daniel Todkill, MBChB, Consultant Epidemiologist, UKHSA Real-time Syndromic Surveillance Team, Dan.Todkill@ukhsa.gov.uk, ORCID 0000-0002-4325-4786

Rashmi Wimalaratna, BSc, MBBS, Clinical Researcher, Oxford University, rashmi.wimalaratna@phc.ox.ac.uk, ORCID - 0009-0000-3244-9679

Senior authors

Matthew Inada-Kim, MBBS, National Clinical Advisor Sepsis, NHS England, matthew.inada-kim@nhs.net, ORCID - 0000-0001-6026-2246

Nick Andrews, PhD, Head of Vaccine Analysis, Immunisation Division, UKHSA, nick.andrews@ukhsa.gov.uk, ORCID-0000-0003-2069-2684

Victoria Tzortziou-Brown, PhD, Vice Chair External Affairs, Royal College of General Practitioners Research and Surveillance Centre, v.tzortzioubrown@qmul.ac.uk, ORCID- 0000-0001-9819-6395

Rachel Byford, BA, Senior SQL Developer, Oxford University, rachel.byford@phc.ox.ac.uk, ORCID - 0000-0002-4792-8995

Maria Zambon, PhD, Head of Influenza and Respiratory Virology, Virus Reference Laboratory, UKHSA, Maria.Zambon@phe.gov.uk, ORCID - 0000-0002-8897-7881

Jamie Lopez-Bernal, PhD, Consultant Epidemiologist, Immunisation and Vaccine Preventable Diseases Division, UKHSA, jamie.lopezbernal2@ukhsa.gov.uk, ORCID - 0000-0002-1301-5653

Simon de Lusignan, MD, FRCGP, Professor of Primary Care & Clinical Informatics, Director RCGP RSC, simon.delusignan@phc.ox.ac.uk, ORCID-0000-0002-8553-2641 (corresponding author)

Radcliffe Primary Care Building, Radcliffe Observatory Quarter, Woodstock Rd, Oxford OX2 6GG
+44 (0)1865 617975

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Abstract

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Introduction:

Pre-pandemic sentinel surveillance focused on improved management of winter pressures, with influenza-like illness (ILI) the key clinical indicator. The World Health Organisation (WHO) global standards for influenza surveillance included monitoring acute respiratory infection (ARI) as well as ILI. The WHO's mosaic framework recommends countries' surveillance strategies include the virological monitoring of respiratory viruses with pandemic potential such as influenza. The Oxford-Royal College of General Practitioner Research and Surveillance Centre (RSC) in collaboration with the UK Health Security Agency (UKHSA), has provided sentinel surveillance since 1967 including virology since 1993.

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To describe the RSC's plans for sentinel surveillance in the 2023-2024 season and evaluate these plans against the WHO mosaic framework.

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Our approach, which includes patient and public involvement, contributes to surveillance objectives across all three domains of the mosaic framework.

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Conclusion:

The RSC extended its surveillance activities to meet more, but not all the mosaic framework's objectives. We have introduced an ARI indicator, seek to expand our surveillance scope, but could do more around transmissibility, and benefit-risk of non-vaccine therapies.

Keywords:
Sentinel Surveillance
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COVID-19
Influenza, Human
Influenza Vaccines
Respiratory Tract Infections
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World Health Organization
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Phenotype
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Introduction

Prior to the coronavirus disease 2019 (COVID-19) pandemic, sentinel surveillance was orientated towards influenza and its associated winter pressures [1-6]. It has subsequently evolved to include a systematic collection of acute respiratory infection (ARI) and a wider range of indicators. The WHO Global Influenza Surveillance and Response System (GISRS) was launched in 1952 to provide a global response to influenza and other respiratory infections [7, 8]. The focus of the GISRS and other national surveillance networks are seasonal influenza monitoring and associated vaccination effectiveness studies [9] [10], as well as pandemic preparedness [11, 12]. Virology testing became an essential component with sero-surveillance introduced into some systems [13]. Pre-pandemic virological testing was largely carried out in the winter season with influenza-like illness (ILI) as the key clinical indicator of community influenza infection [14]. In addition to ILI, ARI started to be used by the European Centre for Disease Prevention and Control (ECDC) as a surveillance indicator [15, 16]. The WHO 2013 global epidemiological standards for influenza surveillance proposed the use of severe ARI (SARI) as an indicator. SARI is defined as a person with incident ARI who is admitted to hospital [17] [18]. The WHO mosaic framework suggests sentinel ILI/ARI/SARI surveillance as the core approach in monitoring epidemiological characteristics of respiratory viruses in interpandemic periods [16].

Subsequent to the COVID-19 pandemic, WHO published its mosaic framework for respiratory disease surveillance [16] [19]. It recommends that countries' surveillance strategies include the virological monitoring of influenza, severe acute respiratory syndrome-coronavirus 2 (SARS-CoV-2), respiratory syncytial virus (RSV) and other viruses with pandemic potential. The mosaic has a broad framework and includes 14 surveillance objectives set out across three domains, (I) Detection and assessment of respiratory viruses, (II) Monitoring their epidemiological characteristics, and (III) Informing on the use of health interventions [16] [19].

The Royal College of General Practitioners (RCGP) has been collecting data about respiratory and other infections in England in its epidemic research centre since 1957 [20]. This research centre became rebranded as the RCGP Research and Surveillance Centre (RSC) and has been conducting sentinel surveillance since 1967 [21], in collaboration with the UK Health Security Agency (UKHSA) and its predecessor bodies. The RSC has included reference laboratory virology since the 1993-1994 season [22]. The network has grown to almost 2,000 practices in England and Wales (31.6% of the active practices) with a contemporary extract of over 19 million patients (31.9% of England and Wales population) in 2023 [23].

This protocol describes the Oxford-RCGP RSC’s plans for the 2023 to 2024 sentinel surveillance season and evaluates them against the WHO mosaic framework. The RSC will be offering all-year-round virology and sentinel surveillance of respiratory infections in collaboration with the UKHSA. Our extended surveillance includes the adoption of SARI as an important severity indicator, alongside ILI and other components of the WHO mosaic framework.

The objectives are to:

(1) Describe the planned patient and public involvement (PPI) with the RSC, with the aims of improving public understanding of the RSC’s programme and co-designing changes to our sentinel surveillance;
(2) Develop an ARI digital phenotype and contemporaneously report the incidence of ARI and SARI, including new severity indicators, using primary care data;
(3) Collect and share high-quality data to support VE studies for COVID-19 and influenza

vaccines in the coming season and enable the reporting of RSV's disease burden;
(4) Ensure the volume of virology and serology sampling from member practices that follow our sampling framework, is of sufficient volume to determine VE by vaccine type, and has the minimum required clinical data recorded;
(5) Introduce technological developments by (1) Utilising general practitioner (GP)-laboratory links to support virology and serology sampling, (2) Establishing a messaging system to enable more representative sampling, as well as targeted sampling when required, (3) Increasing point-of-care testing (POCT) capability, (4) Piloting virology sampling from asymptomatic individuals, and (5) Testing for pneumococcus infection;
(6) Create a biomedical resource that provides a unique longitudinal clinical resource and enables genomic surveillance by linking individual-level human phenotypes to the genomic sequencing of viruses detected in those individuals;
(7) Describe the legal basis and governance framework for conducting sentinel surveillance.

Methods

Comparison with WHO mosaic framework

We describe our approach to sentinel surveillance in functional components. Many of these, such as PPI, span across all of the mosaic's sentinel objectives. Others sit outside or beyond its scope, examples include bacterial causes of infection and information governance requirements. We conclude the results section with a table summarising the surveillance objectives achieved, and those to be delivered beyond its scope.

Patient and public involvement (PPI)

We will use two channels of PPI and engagement within the RSC. The first channel is with national PPI groups, the Health Data Research-UK and the RCGP Patient and Carer Participation Groups. Additional national patient representatives will be recruited from the National Institute for Health Research People in Research portal [24] to ensure geographical representation across England. The second channel includes local patient participation groups of general practice members of the RSC network; opportunities for patients to provide feedback will be communicated to all network practices in England.
We will invite patient representatives to participate in two meetings per year held with the UKHSA and Oxford-RCGP RSC. The meetings aim to raise awareness of surveillance, including its use of patient data, and to gain input on the RSC's work, particularly on optimising the acceptability of sampling and the feedback of results. PPI feedback will be used mainly to improve communication with patients, but may inform other areas of the surveillance. We will send a monthly newsletter covering topics and findings related to surveillance to increase transparency and patient engagement (Multimedia Appendix 1). We will use the cube framework to plan and evaluate PPI [25]. To improve transparency in reporting PPI and its impact, we will use a standard international guideline (GRIPP2 checklist) [26].

Acute respiratory infection (ARI) phenotype

A digital phenotype is a set of rules that allows the identification of cases, such as ILI or ARI, from the computerised medical record (CMR) [27]. At the RSC we have a well-established digital phenotype for ILI. To bring our strategy in line with the most recent WHO recommendations, we are developing a new ARI phenotype for the coming season.
The phenotype is being built around Systematised Nomenclature of Medicine (SNOMED)

Clinical Terms (CT) as this is the National Health Service (NHS)-mandated medical terminology used by all primary care providers [28]. The phenotype consists of code lists representing common conditions that make up the ARI concept. This allows the identification of ARI events coded by member practices in CMR.

We plan to build on the ARI phenotype by characterising the nature and severity of ARI events. We will do this by exploring primary care codes recorded in association with ARI and by linking the primary care data to secondary care records [29, 30]. We differentiate ARI from SARI by checking whether ARI leads to hospitalisation, as recorded in the CMR.

Our phenotype development utilises the Phenotype Execution Modelling Architecture (PhEMA) toolkit [31]. The Health Level-7 Fast Healthcare Interoperability Resources (FHIR) is a global standard for passing healthcare data between systems [31] and is used by the NHS. PhEMA comprises developing an ontological layer using clinical query language and then presenting "code list" using either the Health Level-7 FHIR valueset format or as a SNOMED CT refset. For example, the SNOMED clinical term "Lower respiratory tract infection (disorder)" SCTID: 5041700, has 10 child codes (also known as subtypes), which are all automatically included. If extra child codes are included, they will automatically be included in our definition, unlike the extensional process where "code lists" need frequent review [32]. We have an in-house developed "Helper Tool" to facilitate the selection of SNOMED CT (Figure 1).

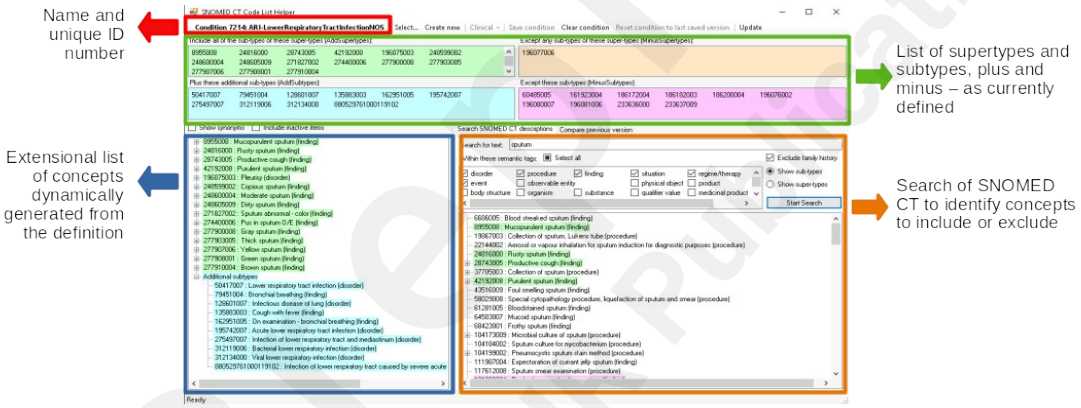


Figure 1: Tool used to facilitate the intentional identification of SNOMED CT refsets.

The lower figure demonstrates how SNOMED CT supertypes and subtypes are included or excluded using the Helper Tool.

High-quality data to support Influenza and COVID-19 vaccine effectiveness and other studies

We will collect and share high-quality data, such as primary care CMR and vaccine exposure data, to support VE studies for COVID-19 and influenza vaccines and enable the reporting of RSV's disease burden in the coming season. We will focus on the data collection areas that need better data quality: (1) Identifying and coding cases of ARI, SARI and ILI as a problem title in CMRs, including whether these are first or new episodes [33]; (2) Consistent capturing of symptoms, signs and any markers of severity upon the presentation of people with ARI; (3) Complete recording of vaccine exposure data, particularly influenza and COVID-19 vaccine, but other vaccines such as pneumococcus may be relevant; (4) Complete recording of sociodemographic and comorbidity data; (5) Recording of outcomes in both

primary care data and linked secondary care dataset. This is particularly important for people who have had virology sampling (see the next section) and practices that are incentivised through data quality payments.
We also need sufficient data (i.e. sample size) to support UKHSA's syndromic surveillance [34, 35], our Weekly Return [36, 37], and our annual report [38]. The Weekly Return and Annual Report will be in their 56th year of production. This will set out to make the network as nationally and regionally representative as possible by recruiting additional practices, particularly to improve virology sampling.

Virology and serology sampling and testing

We collect serology samples from volunteer patients who are attending their practice for a routine blood sample appointment by asking them to contribute one more blood sample to the serology surveillance. Patients were invited through messages before their routine blood tests and were provided a link for further information about the serology surveillance. Verbal consent was taken from the patients before the sampling. We aim to collect 500 serology samples per month from each of the three age groups (under 18s, 18 to 64s, and 65 years and above) with representative sampling across the network. We plan to divide the under 18s age group based on immunisation age groups in the future to allow more granular information to be collected. Serology samples are batch processed in different labs dependent on operational needs, for example understanding vaccine waning in the immunocompromised.
We collect virology samples (nasal and pharyngeal swabs) all year round from patients that present ILI or ARI symptoms to general practices and meanwhile capture their symptom onset day. We aim to reach 1,000 samples per week every week in the coming year. Virological samples collected in RSC surveillance practices are analysed in UKHSA's respiratory virus reference laboratory in Colindale, London. Practices code the results returned from the UKHSA as SNOMED CT or Read code (Multimedia Appendix 2), along with the date that the swab was taken. The test results are used for virological surveillance as well as test-negative case-control studies [39] that evaluate VE for influenza and COVID-19 vaccines.
UKHSA test for a panel of eight viruses (Figure 2). These are (1) SARS-CoV-2, and (2) influenza, where influenza A subtypes are differentiated based on their hemagglutinin (H) and neuraminidase (N) surface proteins. The two subtypes which are commonly in circulation are H1N1 and H3N2, though some influenza A is only reported as influenza A. Influenza B is reported collectively, with close monitoring of circulating lineages, (3) RSV A and B, (4) Human metapneumovirus (hMPV), (5) Other seasonal coronaviruses (NL63, 229E, OC43, HKU1) are tested for, in addition to SARS-CoV-2, (6) Adenovirus, (7) Human rhinovirus, and (8) Enterovirus.

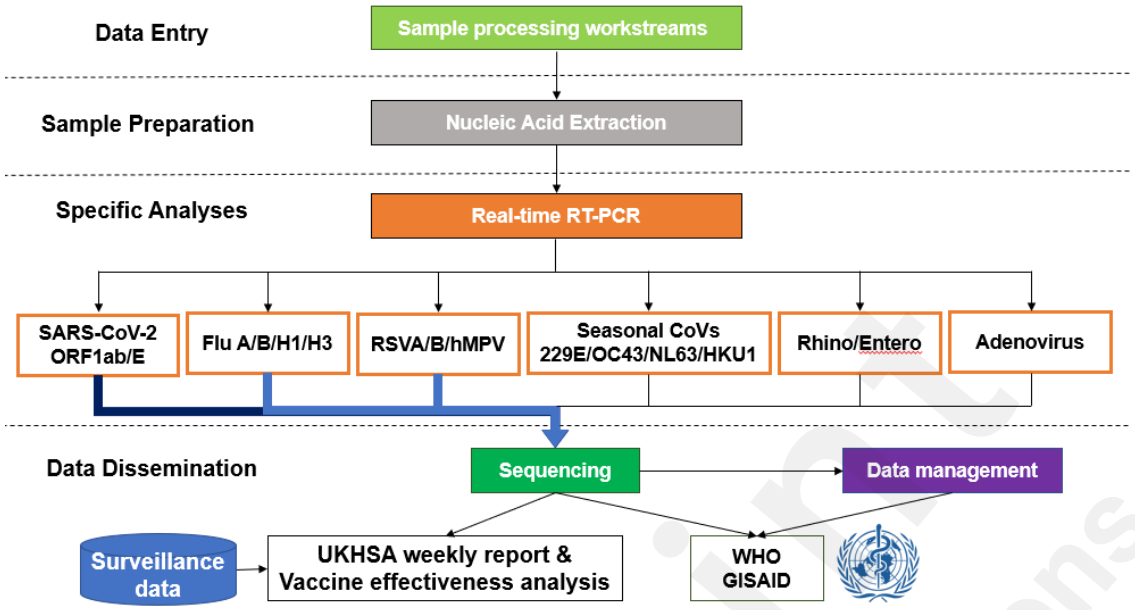


Figure 2: RCGP RSC Reference Lab Virological Surveillance Overview.

To reach a sufficient volume of tests, the behavioural change we want primary care clinicians to achieve is conducting virology and serology sampling where possible and making CMR system entries of high data quality. We will use the behavioural change wheel, otherwise known as the COM-B model, to theorise behavioural change expected in clinicians. This suggests that for a behavioural change (B) to take place, an individual requires capability (C), opportunity (O), and motivation (M) [40]. We are using the COM-B model as a high-level theoretical frame to describe our interaction with practices rather than a formal experimental work.

New technologies and capabilities

We have an ambitious program of introducing new technologies and extending the scope of our surveillance. We are looking to introduce three new technologies in the coming year: (1) Lab-links, integrating our surveillance sampling with online pathology test requests carried out via primary care CMR systems; (2) Creating a POCT-ready nested cohort within the RSC; (3) Introducing a messaging system that enables us to effectively target specific groups for sampling.

The two surveillance capabilities we are looking to introduce are (1) urinary antigen tests (UAG) that test for pneumococcus infection, and (2) collecting virology swabs from asymptomatic infections.

We will conduct a feasibility study of testing for Streptococcus pneumoniae infection using UAG. We would like to do this study over 1 to 2 years, recruiting 2 practices from each NHS region, with patients with ARI having both respiratory swabs and urine tests. We will also pilot asymptomatic testing for our viral panel of test [41]. Running this within the RSC will enable linkage of virology results to medical records, and also the monitoring of household transmission as we can identify people in the same household [42-44]. The protocols for the feasibility and pilot studies will be published separately.

Creation of a biomedical resource

We will complete the work to create a unique biomedical resource which offers two unique opportunities for research. Firstly, we will create a longitudinal database that runs back to the

start of the RSC's involvement in sentinel surveillance in 1967. Secondly, we will link clinical records and the virology results for all tests done at UKHSA's reference laboratory. This will create a resource to support the emerging discipline of genomic surveillance [45, 46] by linking clinical phenotype, as defined in an individual's CMR, at the individual level with details of the infecting virus including its genome's sequence. Summary results of the unique longitudinal data are presented.

The legal basis and governance framework for conducting sentinel surveillance

Pseudonymised primary care data and samples from general practices collected for surveillance purposes are processed under Regulation 3 of the Health Service (Control of Patient Information) Regulations 2002) and annually renewed under Regulation 7 by UKHSA's Caldicott Guardian [47]. Any further research or studies require their own ethical approval and that of the Joint Research and Surveillance Centre Committee approval of the University of Oxford and RCGP.

There are data-sharing agreements in place with every GP practice within the network, where the purpose of data collection and processing activities are staged. We link primary care data collected via sentinel surveillance to secondary care data provided by NHS England via a bespoke data sharing agreement, renewed annually. All the data controllers (UKHSA, RCGP and University of Oxford) complete NHS England's Data security and protection toolkit to meet the performance standards set by the National Data Guardian [48].

Results

Patient and public involvement (PPI)

We presented the protocol to patient representatives in July 2023. Patient representatives proposed promoting self-testing for virology to help increase the uptake of sampling. They also suggested considering swabbing in different settings, including pharmacy, as patients with respiratory illnesses may be more likely to visit a pharmacy rather than a GP.

The patient groups have suggested the following themes and content should form part of our PPI communications: 1) information about how patient data is used in surveillance, 2) how sentinel surveillance fits in with pandemic preparedness and 3) further personal areas of interest, for example, to better understand patterns in patients with long COVID. The PPI representatives expressed that some patients may have concerns about patient confidentiality and data use, which can be overcome by written dissemination and regular engagement.

Based on initial feedback we have tailored our communication to focus on key areas of interest to the public. For example, we delivered a presentation/discussion group to patients at a Midlands practice, which focussed on how data is used for surveillance and how transparency can be improved. We have developed a poster designed for practice waiting rooms to promote awareness of the RSC. We consider patient feedback in training our surveillance practices (e.g., we inform new practices that patients like to receive their swab result, which may enhance patients' experience of care).

Acute respiratory infection (ARI) phenotype

To ensure we identify and classify all relevant coded events in the CMR, the ARI phenotype will be hierarchical. The top level will represent the overall ARI concept. The middle level will include codes for upper respiratory tract infection (URTI), lower respiratory tract infection (LRTI), exacerbations of chronic lung disease and ILI. The bottom level will

include codes for lower-level syndromes, such as sinusitis, that are descendants of middle-level syndrome (Figure 3). We will recommend that RSC network member practices consider coding ARI-associated disease and symptoms as the diagnosis when patients present with ARI symptoms.

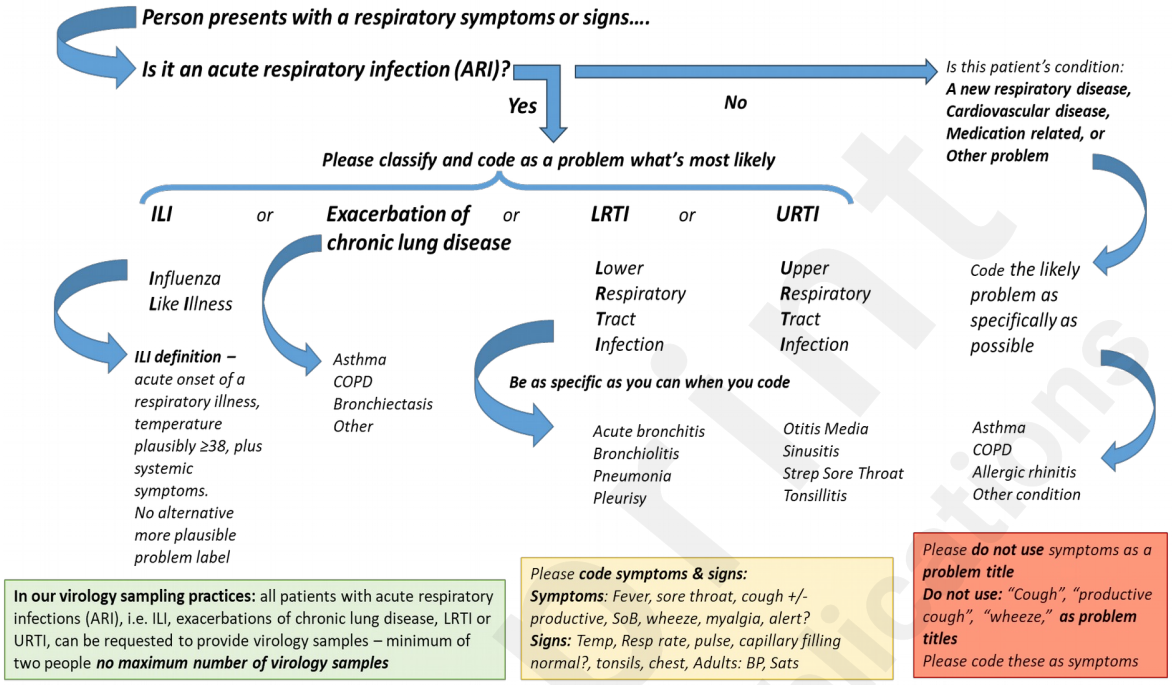


Figure 3: RSC recommendations for classifying the aetiology of respiratory symptoms or signs in people presenting to primary care.

ILI = Influenza-like illness LRTI = Lower Respiratory infection

COPD = Chronic obstructive pulmonary disease URTI = Upper respiratory infection

We also developed a recommended coding sequence for patients presenting ARI to primary care. The overall ARI and ILI signals are important for respiratory surveillance; hence we recommend considering ILI first, using the RSC's ILI definition: an acute respiratory infection with measured or clinically plausible temperature ≥ 38°C, cough, systemic upset such as headache or myalgia, sudden onset and in the absence of a more plausible diagnosis. Our current surveillance categories do not reliably capture exacerbations of chronic lung disease, which is vulnerable to severe outcomes from infective exacerbations [49, 50]. We are therefore asking practices to consider this next. We then ask the consulting clinician to consider lower then upper respiratory infections (LRTI and URTI, Figure 4).

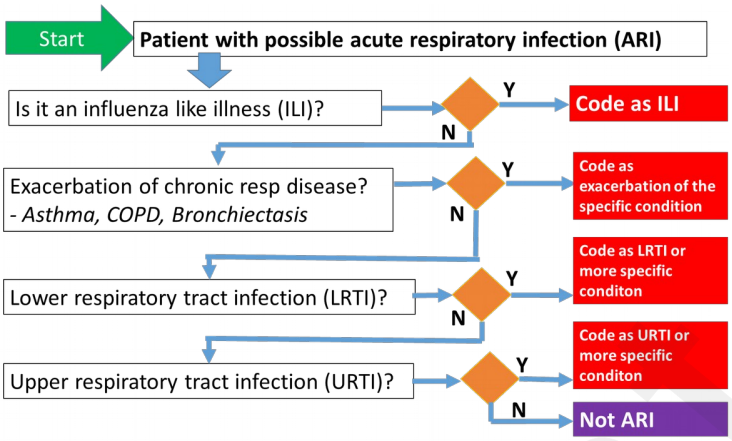


Figure 4: **RSC recommendations for the classification of possible ARI presenting to primary care. The coding sequence is to promote improved recording of ILI cases and exacerbations of chronic respiratory disease.**

We are also standardising the recording of symptoms, signs, and any emergency management decisions made for ARI events, so we request RSC practices record these in the CMR. We fully understand the pressures on consulting time, so will be producing data entry forms that practices can use in the major brands of CMR systems to facilitate high-quality data entry. The key symptom data to be coded are (1) Date of onset of symptoms, (2) Presence of absence of fever because infections, particularly in older people, may not be associated with fever [51], (3) Sore throat symptoms, (4) Cough or no cough, and if coughing is it productive, (5) Coryza and nasal symptoms, (6) Presence or absence of shortness of breath and wheezing. The signs we would like to see coded are (1) measured tympanic temperature, (2) peripheral oxygen saturation, where available, (3) pulse rate, (4) respiratory rate, (5) upper respiratory signs where present including cervical and anterior cervical lymphadenopathy, and any tonsillar exudate or enlargement, (6) lower respiratory signs including wheezing or other physical signs.

High-quality data to support vaccine effectiveness and other studies

To enhance data quality, RSC member practices will receive feedback about their recording of key sociodemographic variables, vaccine exposure, and risk groups. We also provide a dashboard to enable RSC practices to compare their rate of vaccination with the rest of the network (Figure 5).

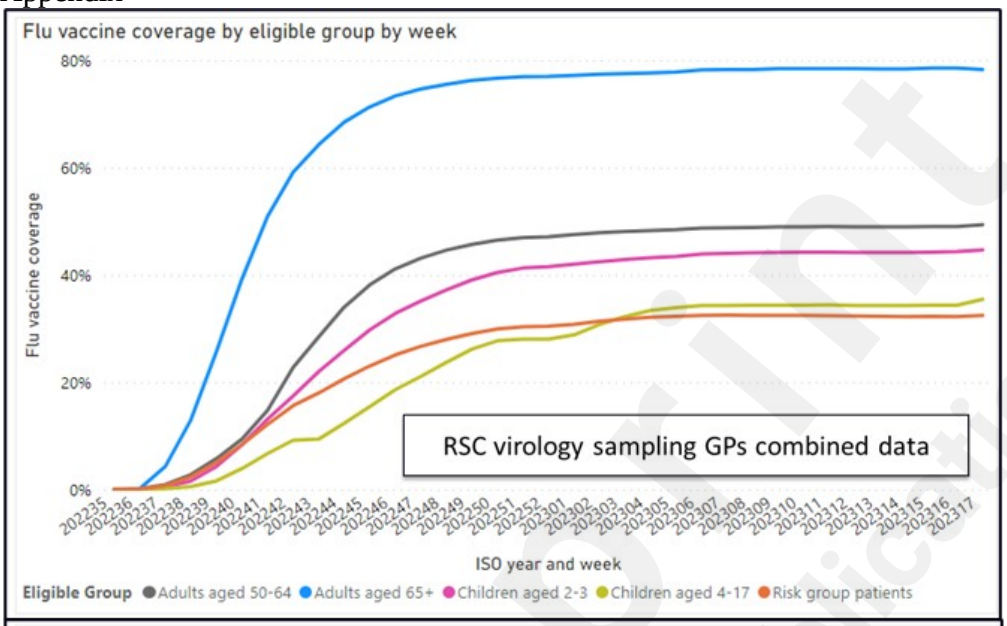
Most of the VE study relevant data are recorded as part of standard care, but some are not recorded to a satisfactory standard. For example, some important sociodemographic data are not automatically recorded, including ethnicity, smoking status, and obesity. Vaccine exposure data should include brand and batch wherever possible, but these recordings are problematic for vaccinations outside general practices.

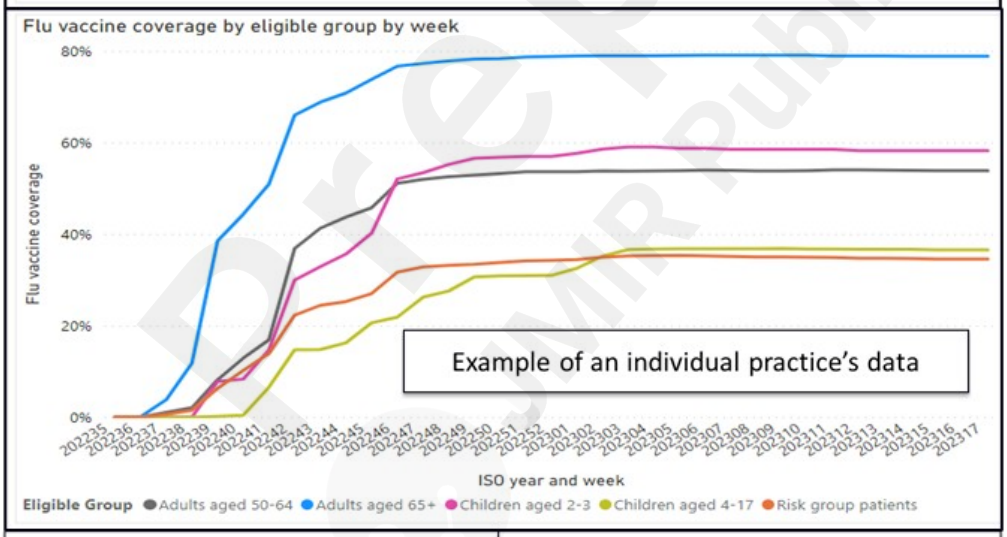
Risk groups and patient outcomes are also important for VE and other studies, while most of these data are recorded well as part of chronic disease management. We also used these data to derive the Cambridge Multimorbidity Score, a single measure of multimorbidity for all adults, and the electronic frailty index (eFI). Whilst eFI can be used from age 50 years, we will use it in the coming season for people 65 years and older [52, 53].

Our data are linked to national collections of hospital and death data, so we can report severe outcomes [54]. Our data is also linkable with the National Immunisation Management

System, which provides vaccination data for COVID-19 and influenza in England. These data will be used to estimate VE, with mid-season and end-of-season studies produced for influenzas, and autumn VE study for COVID-19 vaccine and burden of disease study for RSV. These results will contribute to the Joint Committee on Vaccination and Immunisation impact of vaccine policy, to WHO reviews and be published in peer-reviewed journals.

The protocol for our VE studies is included in the supplementary material (Multimedia Appendix 3).





Example of an individual practice's data

Flu vaccine coverage to date by eligible group

Eligible Group	ISO Year And Week	Denominator	Vaccinated	Vaccine Coverage
Adults aged 50-64	202317	2,107	1,134	53.8%
Adults aged 65+	202317	1,516	1,195	78.8%
Children aged 2-3	202317	225	131	58.2%
Children aged 4-17	202317	1,810	661	36.5%
Other	202317	8,243	470	
Risk group patients	202317	1,555	537	34.5%
Adults aged 50-64	202316	2,107	1,134	53.8%
Adults aged 65+	202316	1,516	1,195	78.8%
Children aged 2-3	202316	225	131	58.2%
Children aged 4-17	202316	1,810	661	36.5%
Other	202316	8,243	470	
Risk group patients	202316	1,555	537	34.5%

RSC virology sampling GPs combined data

Flu vaccine coverage to date by eligible group

Eligible Group	ISO Year And Week	Denominator	Vaccinated	Vaccine Coverage
Adults aged 50-64	202317	845,413	417,379	49.4%
Adults aged 65+	202317	842,986	659,923	78.3%
Children aged 2-3	202317	84,533	37,764	44.7%
Children aged 4-17	202317	616,567	218,644	35.5%
Other	202317	1,603,498	77,032	
Risk group patients	202317	419,625	136,224	32.5%
Adults aged 50-64	202316	1,579,246	774,268	49.0%
Adults aged 65+	202316	1,541,845	1,211,614	78.6%
Children aged 2-3	202316	165,505	73,381	44.3%
Children aged 4-17	202316	1,183,402	406,804	34.4%
Other	202316	3,131,658	149,230	
Risk group patients	202316	806,669	260,162	32.3%

Figure 5: Vaccine exposure data, taken from our observatory, displaying graphically as

well as numerically practice levels of vaccine uptake (2022-2023 season).

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Virology and serology sampling and testing

Ongoing recruitment and checking the representativeness of the network by region will ensure the RSC is representative; maps of the distribution of virology and serology sampling practices, and the entire network are included in Multimedia Appendix 4. We plan to increase the number of virology samples taken each week. The total so far for the 2022-23 season is 11,001, with 878 as the highest number of virology swabs collected in week 51 of the year 2022. The median weekly total is 259 samples with an interquartile range of 173-304 samples. These data have been and will be used to estimate VE for influenza and COVID-19 vaccines using a test negative design, and can be used in the future to study the VE of RSV.

Applying COM-B, our practice liaison team will be working with practices to achieve higher rates of virology samples. We will be continuing our regular visits and weekly and monthly reports to practices, the scope will be driven by our learning from visits about how best to change (increase) sampling behaviour and from our PPI input (Multimedia Appendix 5). Our virology dashboard provides practices with a comparison of what viruses are circulating in their practice, compared to nationally (Figure 6). This can support practices to review their antibiotic prescriptions, anti-viral medication uptake and support better antibiotic stewardship.

We will need to control numbers and better representativeness of our serology sampling in the coming year and produce a dashboard that practices can use to monitor activity (Figure 7). We will be implementing a technology-driven or manual approach to ensure national representativeness by age band and region. We will also be offering paediatric phlebotomy training to encourage sampling in young people and children (Multimedia Appendix 6). The scale of serology sampling will be determined in season.

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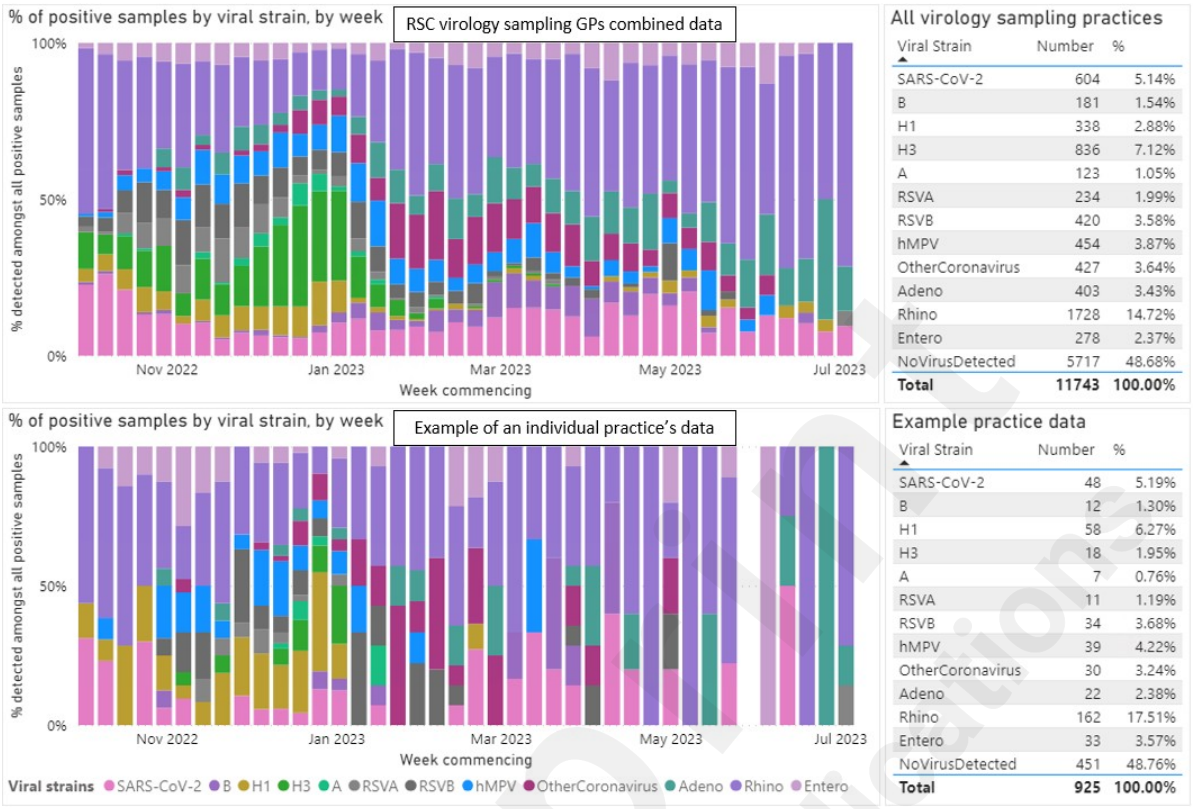

Figure 6: Circulating virology data, taken from our observatory, displaying the % positive samples by viruses for RSC GP's combined and an example individual practice (2022-2023 season).

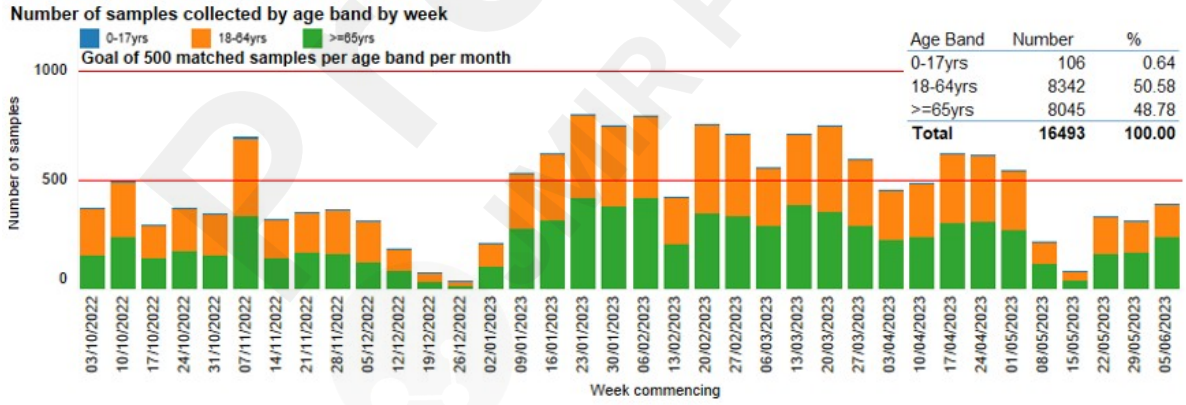

Figure 7: Serology data, taken from our observatory and dashboard, displaying the number of samples collected by age band for RSC GP's combined (2022-2023 season).

New technologies and capabilities

We plan to integrate laboratory-link technologies into the RSC. Currently, customised kits are provided to RSC practices for virology and serology sampling, and these kits are returned to UKHSA laboratories through the post. We plan instead to integrate RSC sampling with the electronic pathology test-requesting systems currently integrated into primary care CMR

systems. The details of the Lab-links program are described in Multimedia Appendix 7. Figure 8 gives an overview of the process.

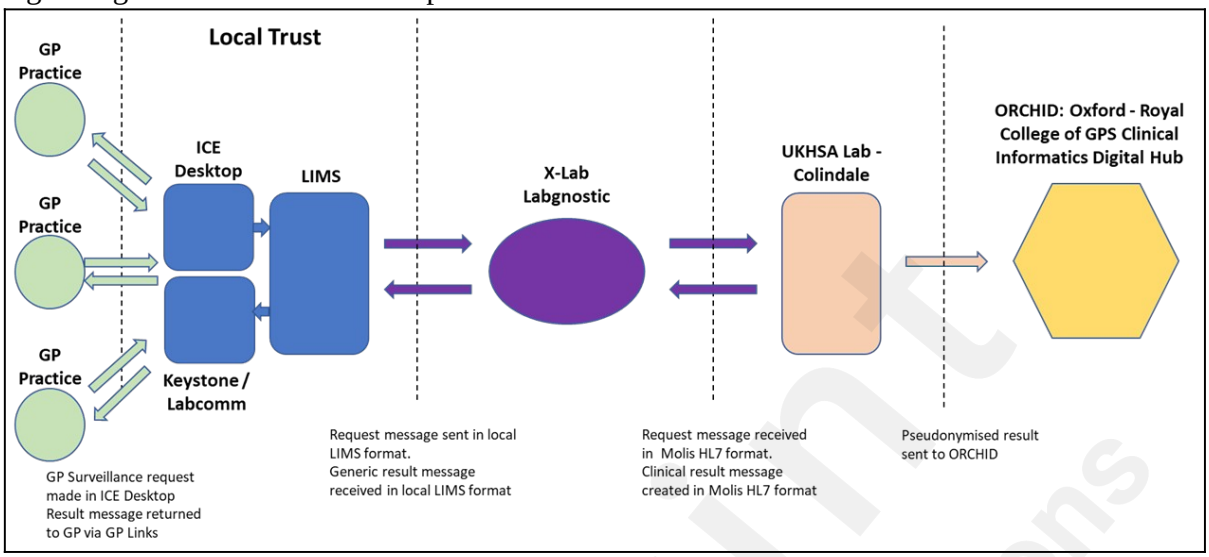

Figure 8: Virological surveillance data workflow. Samples are taken in practice; they pass through the local pathology laboratory to the UKHSA viral reference laboratory at Colindale. Virology results go back to the GP and patient and also into the RSC database.

We will create a POCT nested cohort of practices willing to participate in feasibility studies. The key area of interest is POCT for group A Streptococcal (GAS) infection because there was a higher peak in the incidence of GAS in late 2022 than in the previous eight years (Figure 9). A protocol for using molecular POCT is included in Multimedia Appendix 8 [55-57].

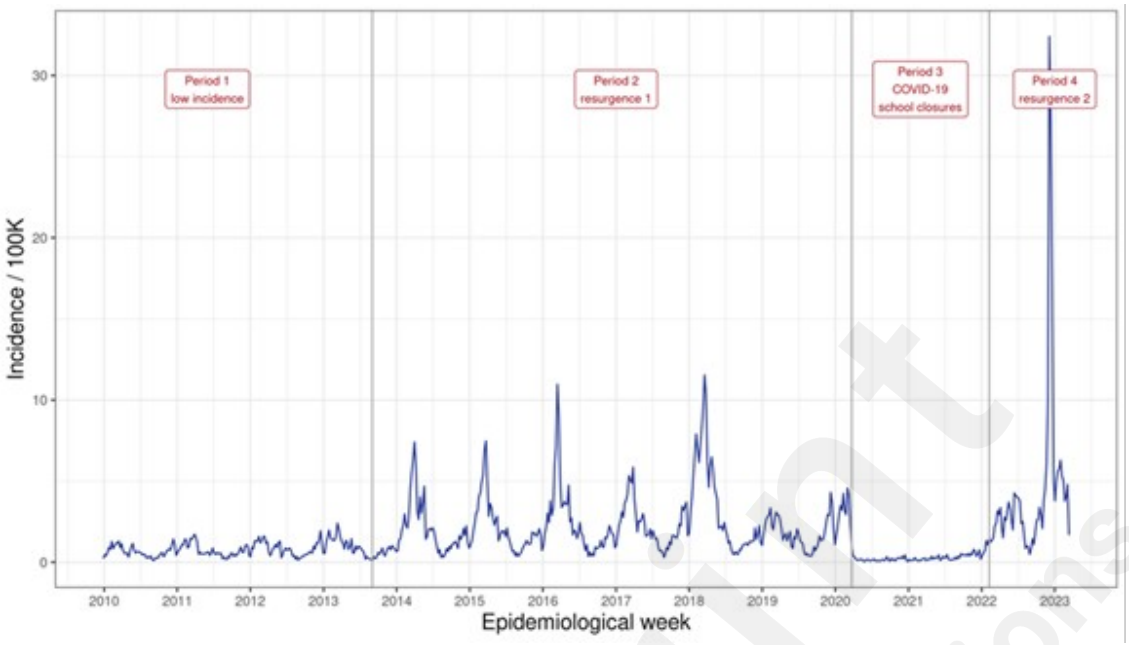

Figure 9: Weekly incidence of scarlet fever or Streptococcal sore throat presenting to the English primary care sentinel network practices 2010 to 2023. The incidence in the last quarter of 2022 was higher than that seen in the previous 10 years.

We will test EMIS Recruit [58] as a messaging system to invite targeted risk groups (immunocompromised) or younger people who have booked for blood tests to consider volunteering to provide an extra blood bottle for serology. The messaging system runs through EMIS Recruit to detect patients in target groups that have a recent blood test request. A message is then sent to the patient to invite them to participate in our serology sampling. The patient will remind the practitioner of their eligibility at the blood test appointment. We will also be asking practices whether there would be interest in paediatric phlebotomy training to increase the sample number in younger children.

We will recruit one or two virology sampling practices per region who volunteer to collect urinary samples to be tested for UAG, inferring pneumococcal infection.

We plan a pilot study of asymptomatic virology sampling. We will start with children under 5 years old attending for vaccination. We may then move on to include people 40 years to 74 years attending NHS Health checks and people 40 years and older attending hypertension clinics in primary care.

Creation of a biomedical resource

The RSC has unique longitudinal data stretching back to 1967. Currently, we are progressing with the assembly of these data into a single quinquagenarian resource (Figure 10). We have curated the rate of ILI incidences between 1967 and 2022 as an example (Figure 11).

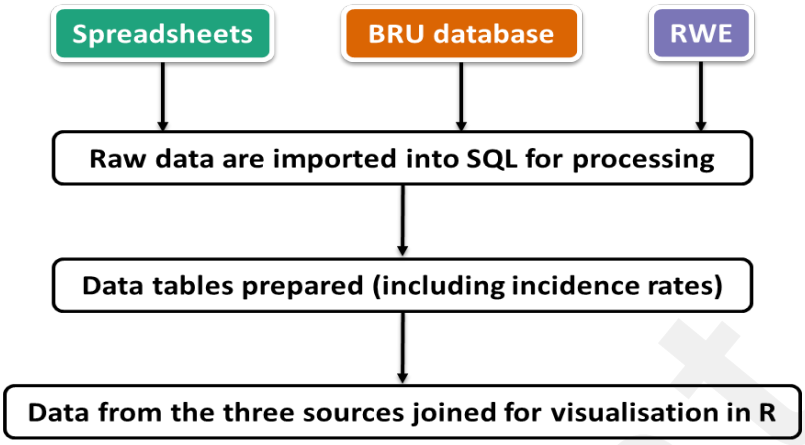

Figure 10: How data since 1967 are assembled within the biomedical resource.

BRU = Birmingham Research Unit, the location of the RSC up to 2013. Up to 1994 spreadsheets were loaded into an Access database, this was then replaced by structured query language (SQL).

RWE = Real World Evidence server, set up in 2013

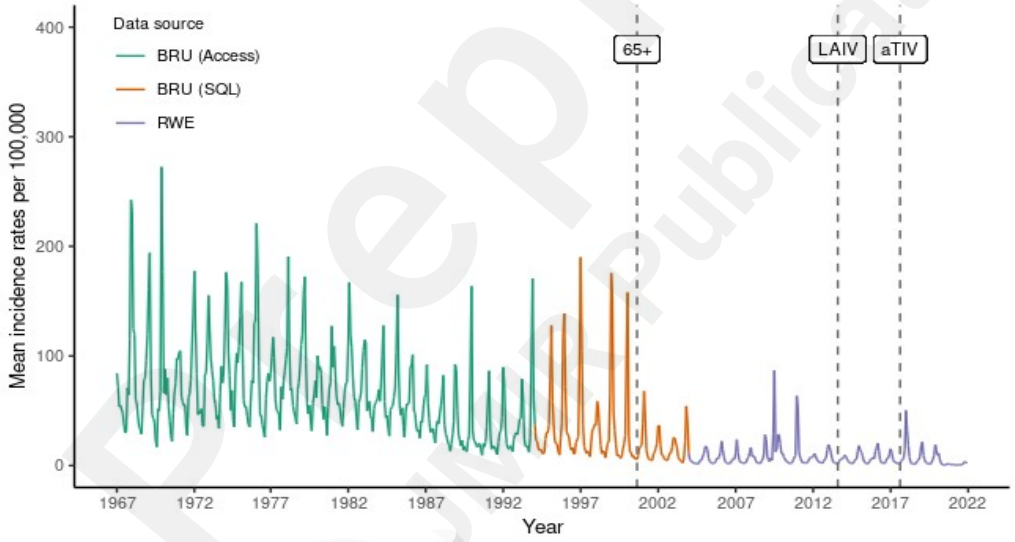

Figure 11: Change in the rate of presentation of ILI to primary care from 1967 to 2022. The year of introduction of different flu vaccines has been added, data are four weekly averages

65+ = introduction of flu vaccine for all aged 65 years and over

LAIV = Live attenuated influenza vaccination, this was introduced for school children

aTIV = adjuvanted Tri-valent influenza vaccine, introduced to improve VE in people 65 years old or older

The legal basis and governance framework for conducting sentinel surveillance

Surveillance is authorised each year through a commissioning letter, authorised by UKHSA, and sent out to all RSC sentinel network general practices. Privacy notices for individuals registered at a GP within the network are publicly available [59]. We request all member practices share these with their registered patients.

Evaluation of RSC surveillance compared with the WHO mosaic framework

The RSC meets many of the surveillance objectives of the WHO mosaic framework but within the scope of its virology, plus primary and secondary care data (Table 1).

In Domain I, *detection and assessment of respiratory viruses*, we have a comprehensive virology panel and a nationally representative primary care network. Our data are strong but could be stronger, with respect to having detailed information about its clinical presentation. Our household key and information about residential care give only limited information about transmission [43]; piloting whether there is asymptomatic spread will provide additional evidence about the spread of the disease.

In Domain II, *epidemiological characteristics of respiratory viruses*, we are strong. Our linked dataset allows us to monitor severe outcomes and mortality. We do not have sufficient coverage of all high-risk settings and do not collect data from hospitals where nosocomial infection is common. We can readily identify community-recorded vulnerable populations, we term these risk groups [60]. We don't directly measure whether healthcare systems are overwhelmed, but we do record community rates of illness compared with other years [61].

In Domain III, *informing about health interventions*, we were able to infer the impact of interventions such as lockdowns and shielding during the COVID-19 pandemic and we can see from our data the impact of school closures [62, 63]. We are strong in measuring vaccine uptake and effectiveness; our data has been used for vaccine adverse events [60, 64]. Due to their central administration, we only have limited abilities to assess the effectiveness of some antivirals and other therapeutics, capabilities are greater where these are recorded in the GP CMR. We have the capability to assess diagnostic tests and will compare POCT with reference virology laboratory results [55] [65]. NHS England ARI hubs are planned to join the network and we plan to evaluate the impact of these networks. We do not provide candidate vaccine viruses.

The RSC has additional surveillance objectives (Table 2). PPI and bacterial surveillance are essential. We could have a role at the system level of exploring how POCT might impact on treatment selection and health outcomes. Additionally, we see being compliant with information governance standards as essential and linkage between clinical and viral sequencing data as enabling genomic surveillance.

Table 1. RSC implementation of the WHO mosaic framework
For each WHO mosaic domain and surveillance objective we summarise the RSC delivery and assess its completeness

WHO Domain	WHO Surveillance objective	RSC delivery - *Each row is cumulative, only new features are added in each row*	Completeness
Domain I: Detection and assessment	Rapidly detect outbreaks and other events	Our sentinel network covers over 32% (N=19 million) population and includes virology and serology sampling. A new ARI phenotype and POCT enhance the capability.	Fully delivered: RSC & UKHSA
	Assess transmissibility and its risk factors, and extent of infection	RSC data includes a household key to identify any household spread, and we can identify people in residential homes. We are starting asymptomatic testing.	Partial delivery: RSC & UKHSA
	Describe clinical presentation and risk factors for severe outcomes	Our ARI phenotype includes, as child concepts, most clinical presentations. We have specified key clinical data to collect. Links to hospital data provide severe outcomes.	Fully delivered: RSC & UKHSA
Domain II: Monitoring epidemiological characteristics	Monitor characteristics of illness over time	Our surveillance of ILI/ARI/SARI, applying the ARI phenotype, enables the ongoing monitoring of respiratory illness over time.	Fully delivered: RSC & UKHSA
	Monitor characteristics of circulating viruses	Our collaboration with the UKHSA in virology and serology sampling (including asymptomatic individuals) supports the monitoring of circulating viruses.	Fully delivered: RSC & UKHSA
	Monitor high-risk settings and vulnerable populations	Long-term investment in UK health computing and pay-for-performance means that primary care records capture risk groups. Other settings may be excluded.	Partial: UKHSA form other settings
	Monitor the impact on and coping abilities of health care systems	We can make year-on-year comparisons of data, running back over many years. However, there are no specific “coping abilities.”	Partially delivered: RSC & UKHSA
Domain III: Informing use of interventions	Monitor the impact of non-medical interventions	We have conducted epidemiological studies to explore the impact of non-medical interventions in COVID-19, e.g., Shielding.	Exemplar studies: RSC & UKHSA
	Provide candidate vaccine viruses	We do not provide candidate vaccine viruses as part of surveillance	Out of scope
	Vaccine coverage, effectiveness, impact, and cost-effectiveness	Standardised national data mean excellent coverage and impact. We are cost-effectiveness capable for health costs, additional data needed for full analyses.	Partially delivered: RSC & UKHSA
	Monitor the effectiveness of antivirals and other therapeutics	We have conducted studies on the effectiveness of antivirals but have limited ability to assess new therapies due to their central administration and data access issues.	Exemplar studies: RSC & UKHSA
	Monitor the effectiveness of diagnostic tests	We have provided a comparison of results from POCT and UKHSA reference virology laboratories. This work could be scaled; see our additional objectives.	Exemplar studies: RSC & UKHSA
	Monitor the effectiveness of clinical care pathways	Where we have access to data, we can monitor care pathways. Gaps include out-of-hours, NHS 111 and care homes. UKHSA Syndromic Surveillance fills these.	Partially delivered: RSC & UKHSA
	Monitor adverse events to vaccines and therapeutics	Ad hoc studies monitor adverse events of interest, either through data (passively) or by providing additional questionnaires. This is not a systematic part of surveillance.	Exemplar studies: RSC & UKHSA

Table 2. RSC additional surveillance objectives that might be added to the WHO mosaic framework.
We summarise RSC surveillance objectives that could be added to the WHO mosaic framework.

Domain	Additional RSC objectives	RSC delivery - *Each row is cumulative, only new features are added in each row*	Completeness
Additional RSC objectives	Patient & public involvement	PPI is fundamentally important. We need the support of patients and the public for what we do. It is hard for us to fulfil our information governance responsibilities regarding informing patients and the public without strong PPI work.	Partially delivered: RSC & UKHSA
	Monitor bacterial infections	Primary and secondary bacterial infections are significant contributors to the burden of respiratory disease. Informing hospitals about these pressures is challenging without considering bacterial diseases. Our innovations include (1) POCT for group A Streptococcal (GAS) infection, and (2) Urinary antigen tests (UAG) to test for pneumococcus infection. We plan to improve the use of routinely collected bacteriology data.	Piloting by RSC in collaboration with UKHSA
	POCT system-level evaluation	Whilst we have evaluated POCT at the individual test level (mainly the sensitivity and specificity of specific virological tests), the RSC has the capability to evaluate the effectiveness of POCT at the system level. Outcomes could include: (1) Antimicrobial stewardship, (2) Use and effectiveness of antivirals, (3) Early intervention in high-risk individuals or populations.	Piloting by RSC
	Secured data governance	Our data governance portfolio including the commissioning letter as described in the legal basis and governance framework for conducting sentinel surveillance facilitates the secure data use within RSC.	Legal and national standards met by RSC
	Genomic surveillance resource	Our biomedical resource will link clinical data to virology sequencing data held in a publicly accessible resource. This will enable the linkage of clinical disease features and outcomes to the viral genomic sequence.	Partially delivered: RSC & UKHSA to complete this Wellcome Trust funded project 2024

Discussion

Principal Findings

The RSC and UKHSA are providing the most comprehensive primary care respiratory infection surveillance in the UK. We have extended the number of surveillance approaches for the coming season, meeting more of the areas proposed in the WHO mosaic framework (Table 1) [19].
In Domain I, *detection and assessment of respiratory viruses*, we have a robust system that has run over decades. However, we have scope to improve the rapidity and reliability of our results by increasing our sampling numbers and data quality so we can better detect changes.
In Domain II, *epidemiological characteristics*, we also have a robust system. There is the potential to integrate work about asymptomatic infection, do more to include high-risk settings in our system, and to develop indicators of our health care system's ability to cope.
Domain III, *informing the use of health interventions*, is an area where we provide some key data but this could be strengthened. We are able to

monitor the impact of non-medical interventions like social distancing [62, 63], but other data are also needed to extend our capability of informing health interventions. We do report vaccine coverage, though data about vaccine exposure where vaccines are not given in primary care is more limited. We have primary care data, and can link to other data, to monitor the effectiveness of antivirals and other therapies but access to centrally held datasets can be slow. We are well placed to report vaccine effectiveness and adverse events of interest following vaccination [37, 54], rapidly when using primary care data but with a greater lead time when we need to link to secondary care data. We can measure the costs of medically attended conditions. However, including measures of health-related quality of life would extend our ability to assess the burden of disease.

Finally, we propose additional objectives that might be added (see Table 2). Among these, we consider that PPI and addressing the burden of primary and secondary bacterial infections are the most important.

Comparison with Prior Work

The strength of the RSC's sentinel surveillance has long been established, but it has now been greatly extended, with the network more than doubling in size during the pandemic [66]. Other countries adapted their surveillance during the COVID-19 pandemic, including setting patient sampling routes outside of primary care (Sweden, Netherlands and Scotland), decentralising the reference testing laboratories (France, Portugal, Scotland and Spain) and optimising digital data collection (Sweden, Netherlands, England, Scotland, France, Portugal and Spain) [67]. Most of these changes were temporary, but the changes in the RSC network, such as the expanded sentinel practices and introducing electronic links to laboratories have remained and will be further developed.

Australia, Belgium, the Netherlands and the US have shown that GPs would like to use more POCTs to help them diagnose acute conditions [68]. Currently, the Welsh government have introduced a pharmacy-led service to undertake a structured clinical assessment using clinical prediction scores and POCT for cases of suspected strep A infection [69].

Strengths and Limitations

The strengths of our network are its size, just under a third of the English national population, the level of sampling and commitment to improving data quality. The network has shown adaptability through the COVID-19 pandemic and a strong partnership working with the UKHSA. We also have collaborations with other European sentinel networks and international collaborations [67]. The UK has a registration-based system that is free at the point of care, which means good population coverage and facilitates the presentation of population-based infection rates. A unique national ID, the NHS number, ensures that primary care data can be linked to hospital and death data, allowing severe outcomes to be reported.

The limitations of routine data are that they are recorded by busy clinicians often working under pressure so can be incomplete. Despite our best efforts, there can be gaps in data quality [70]. It is inevitable that our data will not capture all cases and disease aetiology is in precise. Whilst

https://preprints.jmir.org/preprint/52047 [unpublished, peer-reviewed preprint]

primary care data can be reliably reported within three days in arrears, it is much slower to gain access to and supply of secondary care and other datasets. The national policy is to move towards a smaller number of secure data environments, and the RSC may need to migrate into one of these [71]. NHS primary care is increasingly working at scale, with NHS setting up ARI hubs to work across geographical areas. We are exploring recruiting ARI hubs into our network.

Conclusions

The RSC has grown and adapted through the pandemic. Our biggest areas of change will be the introduction of an ARI phenotype, using technology to reduce the barriers to and hopefully increase the scale and representativeness of virology sampling. There are challenges in implementing change and requesting more consistent data recording risks discouraging practices from remaining part of the RSC. Overall, our plans for the coming season will deliver more of the WHO surveillance mosaic.

Acknowledgements

Participating RSC member practices and their patients for sharing pseudonymised data for disease surveillance, quality improvement, research, and education. Computer system suppliers in English primary care: EMIS, TPP, In Practice Systems, and Wellbeing (Magentus). The RSC's respiratory disease surveillance work is funded by the UKHSA. The Wellcome Biomedical resource is funded by Wellcome Trust (212763/Z/18/Z).

Conflicts of Interest

Simon de Lusignan has received funding through his University from Astra-Zeneca, Eli-Lilly, GSK, MSD, Novo Nordisk, Sanofi, Seqirus, and Takeda, and has been a member of advisory boards for Astra-Zeneca, Sanofi, and Seqirus. He is the Director of the Oxford-RCGP RSC. Uy Hoang has received funding from Sanofi for vaccine-related continuing professional development workshops and has been a member of the advisory board for Janssen. All other authors declared no conflicts of interest.

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Multimedia Appendix

Multimedia Appendix 1: Patient and public involvement - Images from the first monthly newsletter

Multimedia Appendix 2: Coding Virology Swab Results

Multimedia Appendix 3: Proposals for the vaccine effectiveness studies for the coming season

Multimedia Appendix 4: Distribution of virology and serology sampling practices and the entire network

Multimedia Appendix 5: Practice Liaison Team Communications

Multimedia Appendix 6: Summary of Pilot Study to Introduce Training in Paediatric Phlebotomy Training in the RSC Network, by region

Multimedia Appendix 7: An introduction to LabLinks

Multimedia Appendix 8: A protocol for a study using point-of-care testing

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References

1. Bitterman R, Eliakim-Raz N, Vinograd I, Zalmanovici Trestioreanu A, Leibovici L, Paul M. Influenza vaccines in immunosuppressed adults with cancer. Cochrane Database Syst Rev. 2018 Feb 1;2(2):Cd008983. PMID: 29388675. doi: 10.1002/14651858.CD008983.pub3.

2. Demicheli V, Jefferson T, Ferroni E, Rivetti A, Di Pietrantonj C. Vaccines for preventing influenza in healthy adults. Cochrane Database Syst Rev. 2018 Feb 1;2(2):Cd001269. PMID: 29388196. doi: 10.1002/14651858.CD001269.pub6.

3. Gasparini R, Amicizia D, Lai PL, Panatto D. Clinical and socioeconomic impact of seasonal and pandemic influenza in adults and the elderly. Hum Vaccin Immunother. 2012 Jan;8(1):21-8. PMID: 22252007. doi: 10.4161/hv.8.1.17622.

4. Jefferson T, Di Pietrantonj C, Al-Ansary LA, Ferroni E, Thorning S, Thomas RE. Vaccines for preventing influenza in the elderly. Cochrane Database Syst Rev. 2010 Feb 17(2):Cd004876. PMID: 20166072. doi: 10.1002/14651858.CD004876.pub3.

5. Jefferson T, Rivetti A, Di Pietrantonj C, Demicheli V. Vaccines for preventing influenza in healthy children. Cochrane Database Syst Rev. 2018 Feb 1;2(2):Cd004879. PMID: 29388195. doi: 10.1002/14651858.CD004879.pub5.

6. Langer J, Welch VL, Moran MM, Cane A, Lopez SMC, Srivastava A, et al. High Clinical Burden of Influenza Disease in Adults Aged ≥ 65 Years: Can We Do Better? A Systematic Literature Review. Adv Ther. 2023 Apr;40(4):1601-27. PMID: 36790682. doi: 10.1007/s12325-023-02432-1.

7. Hay AJ, McCauley JW. The WHO global influenza surveillance and response system (GISRS)-A future perspective. Influenza Other Respir Viruses. 2018 Sep;12(5):551-7. PMID: 29722140. doi: 10.1111/irv.12565.

8. Ziegler T, Moen A, Zhang W, Cox NJ. Global Influenza Surveillance and Response System: 70 years of responding to the expected and preparing for the unexpected. Lancet. 2022 Sep 24;400(10357):981-2. PMID: 36154679. doi: 10.1016/s0140-6736(22)01741-x.

9. de Fougerolles TR, Damm O, Ansaldi F, Chironna M, Crépey P, de Lusignan S, et al. National influenza surveillance systems in five European countries: a qualitative comparative framework based on WHO guidance. BMC Public Health. 2022 Jun 9;22(1):1151. PMID: 35681199. doi: 10.1186/s12889-022-13433-0.

10. Tenforde MW, Patel MM, Lewis NM, Adams K, Gaglani M, Steingrub JS, et al. Vaccine Effectiveness Against Influenza A(H3N2)-Associated Hospitalized Illness: United States, 2022. Clin Infect Dis. 2023 Mar 21;76(6):1030-7. PMID: 36327388. doi: 10.1093/cid/ciac869.

11. Nannei C, Goldin S, Torelli G, Fatima H, Kumar K, Bubb-Humfryes O, et al. Stakeholders' perceptions of 10years of the Global Action Plan for Influenza Vaccines (GAP) - Results from a survey. Vaccine. 2016 Oct 26;34(45):5393-9. PMID: 27646029. doi: 10.1016/j.vaccine.2016.08.040.

12. Porter RM, Goldin S, Lafond KE, Hedman L, Ungkuldee M, Kurzum J, et al. Does

having a seasonal influenza program facilitate pandemic preparedness? An analysis of vaccine deployment during the 2009 pandemic. Vaccine. 2020 Jan 29;38(5):1152-9. PMID: 31839465. doi: 10.1016/j.vaccine.2019.11.025.

13. de Lusignan S, Borrow R, Tripathy M, Linley E, Zambon M, Hoschler K, et al. Serological surveillance of influenza in an English sentinel network: pilot study protocol. BMJ Open. 2019 Mar 8;9(3):e024285. PMID: 30852535. doi: 10.1136/bmjopen-2018-024285.

14. Vega T, Lozano JE, Meerhoff T, Snacken R, Beauté J, Jorgensen P, et al. Influenza surveillance in Europe: comparing intensity levels calculated using the moving epidemic method. Influenza Other Respir Viruses. 2015 Sep;9(5):234-46. PMID: 26031655. doi: 10.1111/irv.12330.

15. European Centre for Disease Prevention and Control. Operational considerations for respiratory virus surveillance in Europe. 2022 [cited 2023 27 July]; Available from: https://www.ecdc.europa.eu/en/publications-data/operational-considerations-respiratory-virus-surveillance-europe.

16. Mott JA, Bergeri I, Lewis HC, Mounts AW, Briand SC. Facing the future of respiratory virus surveillance: "The mosaic surveillance framework". Influenza Other Respir Viruses. 2023 Mar;17(3):e13122. PMID: 36970570. doi: 10.1111/irv.13122.

17. World Health Organization. Global epidemiological surveillance standards for influenza. 2013 [cited 2023 10 July]; Available from: https://apps.who.int/iris/rest/bitstreams/1210991/retrieve.

18. Fitzner J, Qasmieh S, Mounts AW, Alexander B, Besselaar T, Briand S, et al. Revision of clinical case definitions: influenza-like illness and severe acute respiratory infection. Bull World Health Organ. 2018 Feb 1;96(2):122-8. PMID: 29403115. doi: 10.2471/blt.17.194514.

19. World Health Organisation. Facing the future of respiratory virus surveillance: The mosaic surveillance framework. . 2023 [cited 2023 17 July]; Available from: https://cdn.who.int/media/docs/default-source/mosaic/230315-who_whe_crafting-the-mosaic_brochure_ver1_14032023_la-final.pdf

20. Booth CC. Research and the general practitioner. Br Med J (Clin Res Ed). 1987 Dec 19-26;295(6613):1614-9. PMID: 3121094. doi: 10.1136/bmj.295.6613.1614.

21. de Lusignan S, Correa A, Smith GE, Yonova I, Pebody R, Ferreira F, et al. RCGP Research and Surveillance Centre: 50 years' surveillance of influenza, infections, and respiratory conditions. Br J Gen Pract. 2017 Oct;67(663):440-1. PMID: 28963401. doi: 10.3399/bjgp17X692645.

22. Dedman DJ, Joseph CA, Chakraverty P, Fleming DM, Watson JM. Influenza surveillance, England and Wales: October 1993 to June 1994. Commun Dis Rep CDR Rev. 1994 Dec 9;4(13):R164-8. PMID: 7531565.

23. Leston M, Elson WH, Watson C, Lakhani A, Aspden C, Bankhead CR, et al. Representativeness, Vaccination Uptake, and COVID-19 Clinical Outcomes 2020-2021 in the UK Oxford-Royal College of General Practitioners Research and Surveillance Network: Cohort

Profile Summary. JMIR Public Health Surveill. 2022 Dec 19;8(12):e39141. PMID: 36534462. doi: 10.2196/39141.

24. National Institute for Health and Care Research. People in Research. 2023 [cited 2023 17 July]; Available from: https://www.peopleinresearch.org/.

25. Gibson A, Welsman J, Britten N. Evaluating patient and public involvement in health research: from theoretical model to practical workshop. Health Expect. 2017 Oct;20(5):826-35. PMID: 28664563. doi: 10.1111/hex.12486.

26. Staniszewska S, Brett J, Simera I, Seers K, Mockford C, Goodlad S, et al. GRIPP2 reporting checklists: tools to improve reporting of patient and public involvement in research. BMJ. 2017;358:j3453. doi: 10.1136/bmj.j3453.

27. Denaxas S, Gonzalez-Izquierdo A, Direk K, Fitzpatrick NK, Fatemifar G, Banerjee A, et al. UK phenomics platform for developing and validating electronic health record phenotypes: CALIBER. J Am Med Inform Assoc. 2019 Dec 1;26(12):1545-59. PMID: 31329239. doi: 10.1093/jamia/ocz105.

28. Chang E, Mostafa J. The use of SNOMED CT, 2013-2020: a literature review. J Am Med Inform Assoc. 2021 Aug 13;28(9):2017-26. PMID: 34151978. doi: 10.1093/jamia/ocab084.

29. de Lusignan S. Codes, classifications, terminologies and nomenclatures: definition, development and application in practice. Inform Prim Care. 2005;13(1):65-70. PMID: 15949178. doi: 10.14236/jhi.v13i1.580.

30. Domínguez À, Soldevila N, Torner N, Martínez A, Godoy P, Rius C, et al. Usefulness of Clinical Definitions of Influenza for Public Health Surveillance Purposes. Viruses. 2020 Jan 14;12(1). PMID: 31947696. doi: 10.3390/v12010095.

31. Brandt PS, Pacheco JA, Adekkanattu P, Sholle ET, Abedian S, Stone DJ, et al. Design and validation of a FHIR-based EHR-driven phenotyping toolbox. Journal of the American Medical Informatics Association. 2022;29(9):1449-60.

32. James AG, Ng E, Shah PS. A reference set of SNOMED terms for the structured representation of respiratory disorders of the newborn infant. Stud Health Technol Inform. 2009;150:243-7. PMID: 19745305.

33. Smith N, Livina V, Byford R, Ferreira F, Yonova I, de Lusignan S. Automated Differentiation of Incident and Prevalent Cases in Primary Care Computerised Medical Records (CMR). Stud Health Technol Inform. 2018;247:151-5. PMID: 29677941.

34. Smith S, Morbey R, de Lusignan S, Pebody RG, Smith GE, Elliot AJ. Investigating regional variation of respiratory infections in a general practice syndromic surveillance system. J Public Health (Oxf). 2021 Jun 7;43(2):e153-e60. PMID: 32009178. doi: 10.1093/pubmed/fdaa014.

35. Morbey R, Smith G, Oliver I, Edeghere O, Lake I, Pebody R, et al. Evaluating multi-purpose syndromic surveillance systems - a complex problem. Online J Public Health Inform. 2021;13(3):E15. PMID: 35082977. doi: 10.5210/ojphi.v13i3.10818.

36. Fleming DM. Weekly Returns Service of the Royal College of General Practitioners. Commun Dis Public Health. 1999 Jun;2(2):96-100. PMID: 10402742.

37. de Lusignan S, Lopez Bernal J, Byford R, Amirthalingam G, Ferreira F, Akinyemi O, et al. Influenza and Respiratory Virus Surveillance, Vaccine Uptake, and Effectiveness at a Time of Cocirculating COVID-19: Protocol for the English Primary Care Sentinel System for 2020-2021. JMIR Public Health Surveill. 2021 Feb 19;7(2):e24341. PMID: 33605892. doi: 10.2196/24341.

38. de Lusignan S FF, Anand S, Byford R, Sherlock S, Okusi C. RCGP Research and Surveillance Centre: Weekly Returns Service Annual Report 2019-2020. London, UK: Royal College of General Practitioners, 2020.

39. Chua H, Feng S, Lewnard JA, Sullivan SG, Blyth CC, Lipsitch M, et al. The Use of Test-negative Controls to Monitor Vaccine Effectiveness: A Systematic Review of Methodology. Epidemiology. 2020 Jan;31(1):43-64. PMID: 31609860. doi: 10.1097/ede.0000000000001116.

40. Michie S, van Stralen MM, West R. The behaviour change wheel: a new method for characterising and designing behaviour change interventions. Implement Sci. 2011 Apr 23;6:42. PMID: 21513547. doi: 10.1186/1748-5908-6-42.

41. Ma Q, Liu J, Liu Q, Kang L, Liu R, Jing W, et al. Global Percentage of Asymptomatic SARS-CoV-2 Infections Among the Tested Population and Individuals With Confirmed COVID-19 Diagnosis: A Systematic Review and Meta-analysis. JAMA Netw Open. 2021 Dec 1;4(12):e2137257. PMID: 34905008. doi: 10.1001/jamanetworkopen.2021.37257.

42. de Lusignan S, Sherlock J, Ferreira F, O'Brien S, Joy M. Household presentation of acute gastroenteritis in a primary care sentinel network: retrospective database studies. BMC Public Health. 2020 Apr 5;20(1):445. PMID: 32248812. doi: 10.1186/s12889-020-08525-8.

43. de Lusignan S, Sherlock J, Akinyemi O, Pebody R, Elliot A, Byford R, et al. Household presentation of influenza and acute respiratory illnesses to a primary care sentinel network: retrospective database studies (2013-2018). BMC Public Health. 2020 Nov 20;20(1):1748. PMID: 33218318. doi: 10.1186/s12889-020-09790-3.

44. Joy M, Hobbs FR, Bernal JL, Sherlock J, Amirthalingam G, McGagh D, et al. Excess mortality in the first COVID pandemic peak: cross-sectional analyses of the impact of age, sex, ethnicity, household size, and long-term conditions in people of known SARS-CoV-2 status in England. Br J Gen Pract. 2020 Dec;70(701):e890-e8. PMID: 33077508. doi: 10.3399/bjgp20X713393.

45. Robishaw JD, Alter SM, Solano JJ, Shih RD, DeMets DL, Maki DG, et al. Genomic surveillance to combat COVID-19: challenges and opportunities. Lancet Microbe. 2021 Sep;2(9):e481-e4. PMID: 34337584. doi: 10.1016/s2666-5247(21)00121-x.

46. Chen Z, Azman AS, Chen X, Zou J, Tian Y, Sun R, et al. Global landscape of SARS-CoV-2 genomic surveillance and data sharing. Nat Genet. 2022 Apr;54(4):499-507. PMID: 35347305. doi: 10.1038/s41588-022-01033-y.

47. Taylor MJ. LEGAL BASES FOR DISCLOSING CONFIDENTIAL PATIENT INFORMATION FOR PUBLIC HEALTH: DISTINGUISHING BETWEEN HEALTH PROTECTION AND HEALTH IMPROVEMENT. Med Law Rev. 2015 Summer;23(3):348-74. PMID: 25995294. doi: 10.1093/medlaw/fwv018.

48. University of Oxford - Medical Sciences Division – Nuffield Department of Primary Care Health Sciences (Radcliffe Observatory Quarter WR, Oxford, OX2 6GG). Data Security and Protection Toolkit. 2023 [cited 2023 17 July]; Available from: https://www.dsptoolkit.nhs.uk/OrganisationSearch/EE133863-MSD-NDPCHS.

49. Oshagbemi OA, Keene SJ, Driessen JHM, Jordan R, Wouters EFM, de Boer A, et al. Trends in moderate and severe exacerbations among COPD patients in the UK from 2005 to 2013. Respir Med. 2018 Nov;144:1-6. PMID: 30366578. doi: 10.1016/j.rmed.2018.09.010.

50. Bloom CI, Nissen F, Douglas IJ, Smeeth L, Cullinan P, Quint JK. Exacerbation risk and characterisation of the UK's asthma population from infants to old age. Thorax. 2018 Apr;73(4):313-20. PMID: 29074814. doi: 10.1136/thoraxjnl-2017-210650.

51. Smith BJ, Price DJ, Johnson D, Garbutt B, Thompson M, Irving LB, et al. Influenza With and Without Fever: Clinical Predictors and Impact on Outcomes in Patients Requiring Hospitalization. Open Forum Infect Dis. 2020 Jul;7(7):ofaa268. PMID: 33123614. doi: 10.1093/ofid/ofaa268.

52. Tsang RS, Joy M, Whitaker H, Sheppard JP, Williams J, Sherlock J, et al. Development of a modified Cambridge Multimorbidity Score for use with SNOMED CT: an observational English primary care sentinel network study. Br J Gen Pract. 2023 Jun;73(731):e435-e42. PMID: 37130611. doi: 10.3399/bjgp.2022.0235.

53. Walsh B, Fogg C, Harris S, Roderick P, de Lusignan S, England T, et al. Frailty transitions and prevalence in an ageing population: longitudinal analysis of primary care data from an open cohort of adults aged 50 and over in England, 2006-2017. Age Ageing. 2023 May 1;52(5). PMID: 37140052. doi: 10.1093/ageing/afad058.

54. Agrawal U, Bedston S, McCowan C, Oke J, Patterson L, Robertson C, et al. Severe COVID-19 outcomes after full vaccination of primary schedule and initial boosters: pooled analysis of national prospective cohort studies of 30 million individuals in England, Northern Ireland, Scotland, and Wales. Lancet. 2022 Oct 15;400(10360):1305-20. PMID: 36244382. doi: 10.1016/s0140-6736(22)01656-7.

55. de Lusignan S, Hoang U, Liyanage H, Tripathy M, Yonova I, Byford R, et al. Integrating molecular point-of-care testing for influenza into primary care: a mixed-methods feasibility study. Br J Gen Pract. 2020 Aug;70(697):e555-e62. PMID: 32661013. doi: 10.3399/bjgp20X710897.

56. de Lusignan S, Hoang U, Liyanage H, Tripathy M, Sherlock J, Joy M, et al. Using Point of Care Testing to estimate influenza vaccine effectiveness in the English primary care sentinel surveillance network. PLoS One. 2021;16(3):e0248123. PMID: 33705452. doi: 10.1371/journal.pone.0248123.

57. Hoang U, Williams A, Smylie J, Aspden C, Button E, Macartney J, et al. The Impact of

https://preprints.jmir.org/preprint/52047 [unpublished, peer-reviewed preprint]

Point-of-Care Testing for Influenza on Antimicrobial Stewardship (PIAMS) in UK Primary Care: Protocol for a Mixed Methods Study. JMIR Res Protoc. 2023 Jun 16;12:e46938. PMID: 37327029. doi: 10.2196/46938.

58. EMIS. Recruit: Enabling primary care professionals to easily identify and connect with patients eligible to take part in clinical trials. 2023 [cited 2023 20 July]; Available from: https://www.emishealth.com/products/recruit.

59. ORCHID. Orchid Data Subject Privacy Notice. 2023 [cited 2023 20 July]; Available from: https://orchid.phc.ox.ac.uk/privacy-policy.

60. Whitaker HJ, Tsang RSM, Byford R, Aspden C, Button E, Sebastian Pillai P, et al. COVID-19 vaccine effectiveness against hospitalisation and death of people in clinical risk groups during the Delta variant period: English primary care network cohort study. J Infect. 2023 Aug 12. PMID: 37579793. doi: 10.1016/j.jinf.2023.08.005.

61. Pebody RG, Green HK, Warburton F, Sinnathamby M, Ellis J, Mølbak K, et al. Significant spike in excess mortality in England in winter 2014/15 - influenza the likely culprit. Epidemiol Infect. 2018 Jul;146(9):1106-13. PMID: 29743125. doi: 10.1017/s0950268818001152.

62. Zarif A, Joy M, Sherlock J, Sheppard JP, Byford R, Akinyemi O, et al. The impact of primary care supported shielding on the risk of mortality in people vulnerable to COVID-19: English sentinel network matched cohort study. J Infect. 2021 Aug;83(2):228-36. PMID: 34004222. doi: 10.1016/j.jinf.2021.04.033.

63. Bernal JL, Sinnathamby MA, Elgohari S, Zhao H, Obi C, Coughlan L, et al. The impact of social and physical distancing measures on COVID-19 activity in England: findings from a multi-tiered surveillance system. Euro Surveill. 2021 Mar;26(11). PMID: 33739255. doi: 10.2807/1560-7917.Es.2021.26.11.2001062.

64. Tsang RS, Joy M, Byford R, Robertson C, Anand SN, Hinton W, et al. Adverse events following first and second dose COVID-19 vaccination in England, October 2020 to September 2021: a national vaccine surveillance platform self-controlled case series study. Euro Surveill. 2023 Jan;28(3). PMID: 36695484. doi: 10.2807/1560-7917.Es.2023.28.3.2200195.

65. Nicholson BD, Hayward G, Turner PJ, Lee JJ, Deeks A, Logan M, et al. Rapid community point-of-care testing for COVID-19 (RAPTOR-C19): protocol for a platform diagnostic study. Diagn Progn Res. 2021 Feb 8;5(1):4. PMID: 33557927. doi: 10.1186/s41512-021-00093-8.

66. Meci A, Du Breuil F, Vilcu A, Pitel T, Guerrisi C, Robard Q, et al. The Sentiworld project: global mapping of sentinel surveillance networks in general practice. BMC Prim Care. 2022 Jul 14;23(1):173. PMID: 35836123. doi: 10.1186/s12875-022-01776-x.

67. Bagaria J, Jansen T, Marques DF, Hooiveld M, McMenamin J, de Lusignan S, et al. Rapidly adapting primary care sentinel surveillance across seven countries in Europe for COVID-19 in the first half of 2020: strengths, challenges, and lessons learned. Euro Surveill. 2022 Jun;27(26). PMID: 35775429. doi: 10.2807/1560-7917.Es.2022.27.26.2100864.

68. Minnaard MC, van de Pol AC, Hopstaken RM, van Delft S, Broekhuizen BD, Verheij TJ, et al. C-reactive protein point-of-care testing and associated antibiotic prescribing. Fam Pract. 2016 Aug;33(4):408-13. PMID: 27230745. doi: 10.1093/fampra/cmw039.

69. Mantzourani E, Cannings-John R, Evans A, Ahmed H. To swab or not to swab? Using point-of-care tests to detect Group A Streptococcus infections as part of a Sore Throat Test and Treat service in community pharmacy. J Antimicrob Chemother. 2022 Feb 23;77(3):803-6. PMID: 35038341. doi: 10.1093/jac/dkab470.

70. Mayor N, Tsang R, Joy M, Hobbs FR, de Lusignan S. Long covid: coding is caring. BMJ. 2021;373:n1262. doi: 10.1136/bmj.n1262.

71. Lusignan Sd, Correa A, Smith GE, Yonova I, Pebody R, Ferreira F, et al. RCGP Research and Surveillance Centre: 50 years' surveillance of influenza, infections, and respiratory conditions. British Journal of General Practice. 2017;67(663):440-1. doi: 10.3399/bjgp17X692645.

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Abbreviations

ARI	acute respiratory infection
CMR	Computerised Medical Record
COVID-19	Coronavirus Disease 2019
CT	Clinical Terms
ECDC	European Centre for Disease Prevention and Control
eFI	Electronic Frailty Index
FHIR	Fast Healthcare Interoperability Resources
GAS	Group A Streptococcal
GISRS	Global Influenza Surveillance and Response System
GP	General Practitioner
hMPV	Human Metapneumovirus
ILI	Influenza-like Illness
IQR	Interquartile Range
LRTI	Lower Respiratory Tract Infection
NHS	National Health Service
PhEMA	Phenotype Execution Modelling Architecture
POCT	Point-Of-Care Testing
PPI	Patient and Public Involvement
RCGP	Royal College of General Practitioners
RSC	Research and Surveillance Centre
RSV	Respiratory Syncytial Virus
SARI	Severe Acute Respiratory Infection
SARS-CoV-2	Severe Acute Respiratory Syndrome-Coronavirus 2
SNOMED	Systematised Nomenclature of Medicine
UAG	Urinary Antigen Tests
UKHSA	UK Health Security Agency
URTI	Upper Respiratory Tract Infection
VE	Vaccine Effectiveness
WHO	World Health Organisation

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Supplementary Files

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Figures

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Tool used to facilitate the intentional identification of SNOMED CT refsets. The lower figure demonstrates how SNOMED CT supertypes and subtypes are included or excluded using the Helper Tool.

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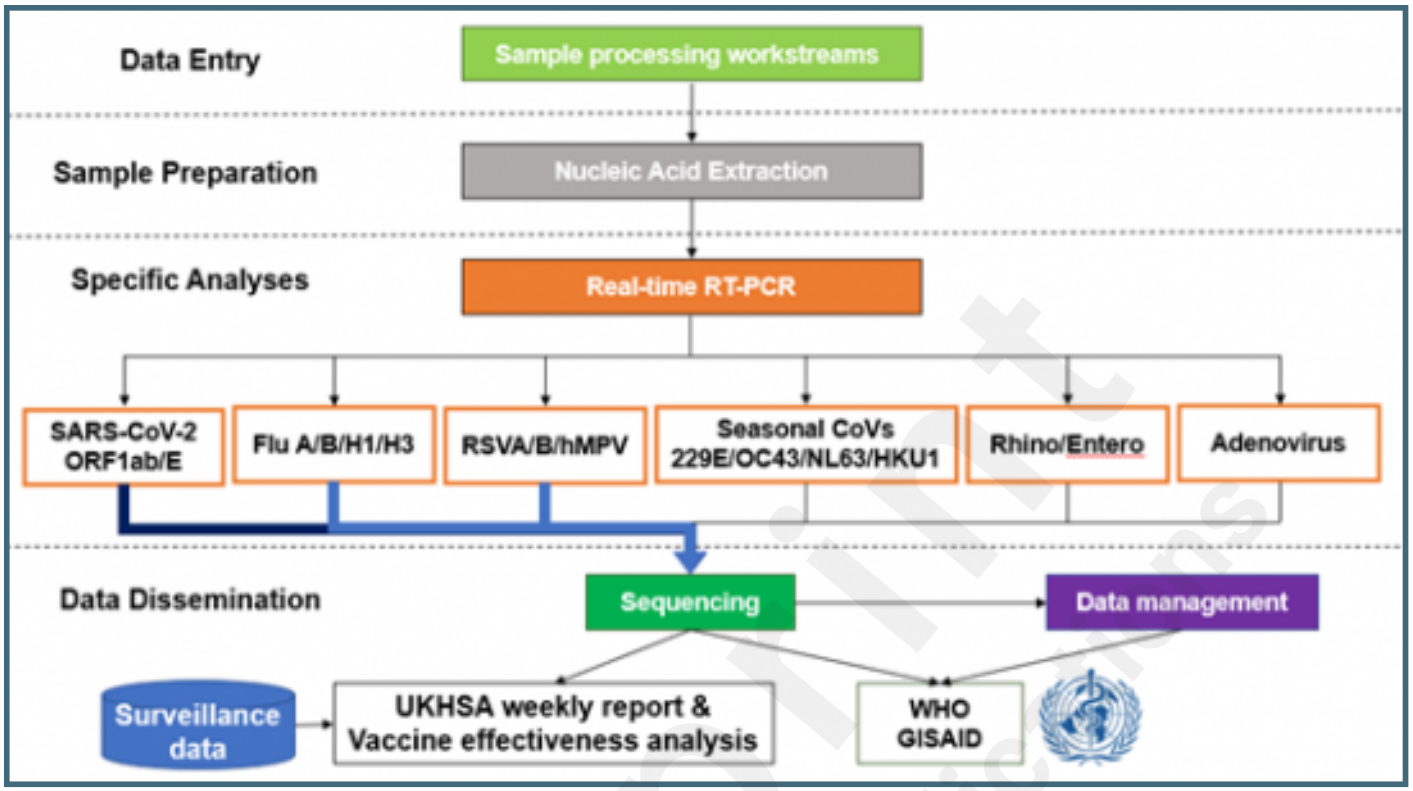
RCGP RSC Reference Lab Virological Surveillance Overview.



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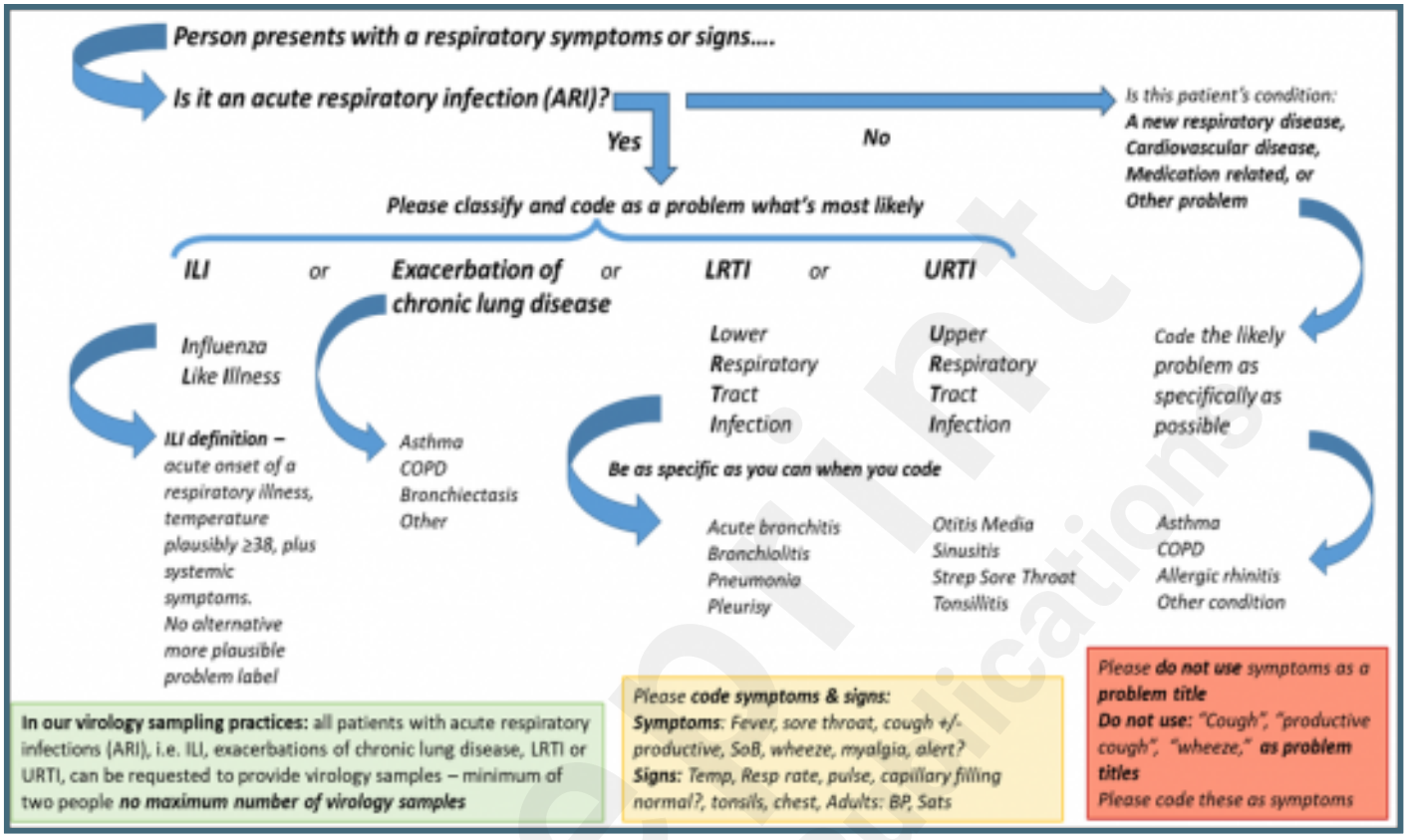
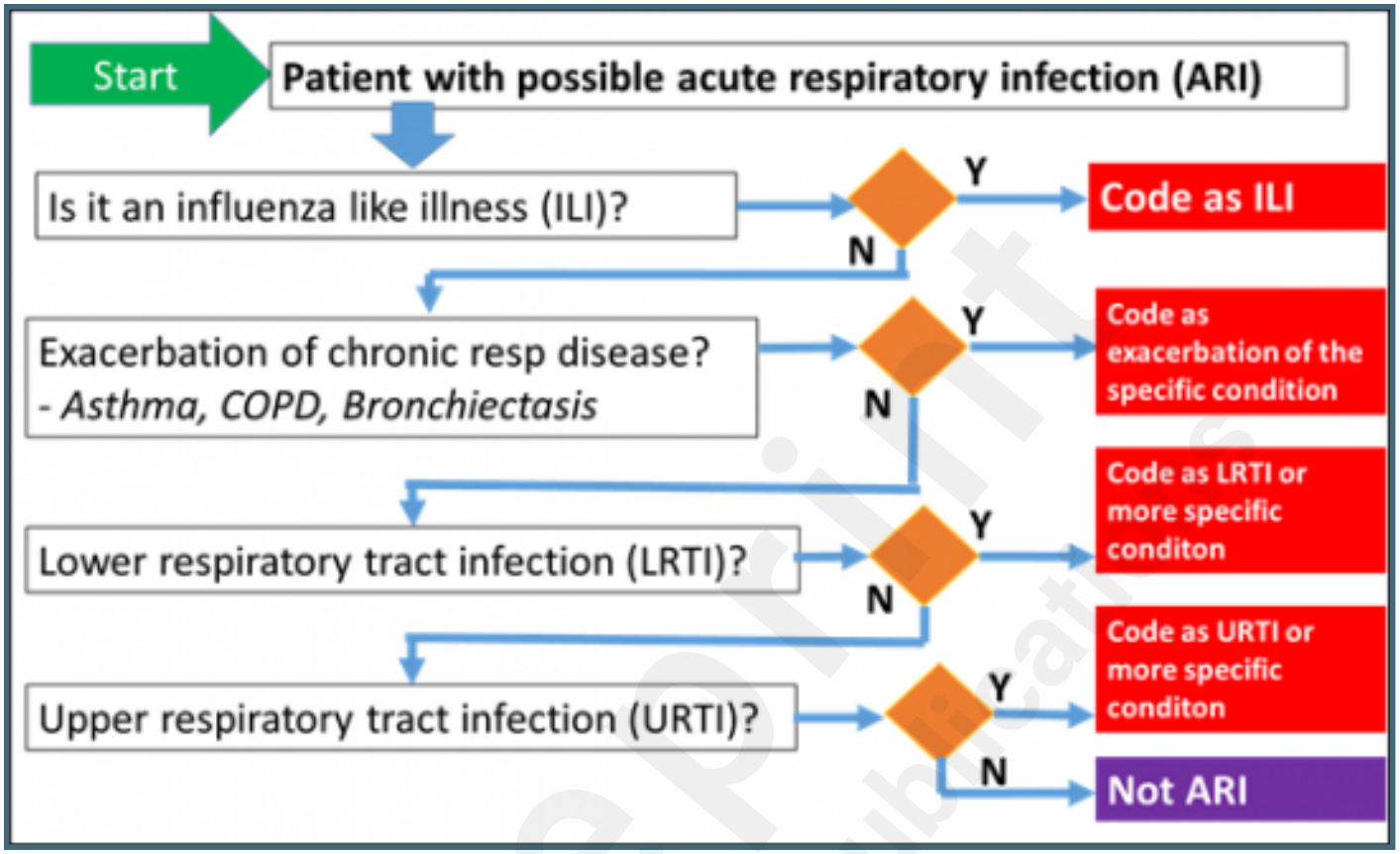
RSC recommendations for classifying the aetiology of respiratory symptoms or signs in people presenting to primary care. ILI = Influenza-like illness LRTI = Lower Respiratory infection COPD = Chronic obstructive pulmonary disease URTI = Upper respiratory infection.



RSC recommendations for the classification of possible ARI presenting to primary care. The coding sequence is to promote improved recording of ILI cases and exacerbations of chronic respiratory disease.



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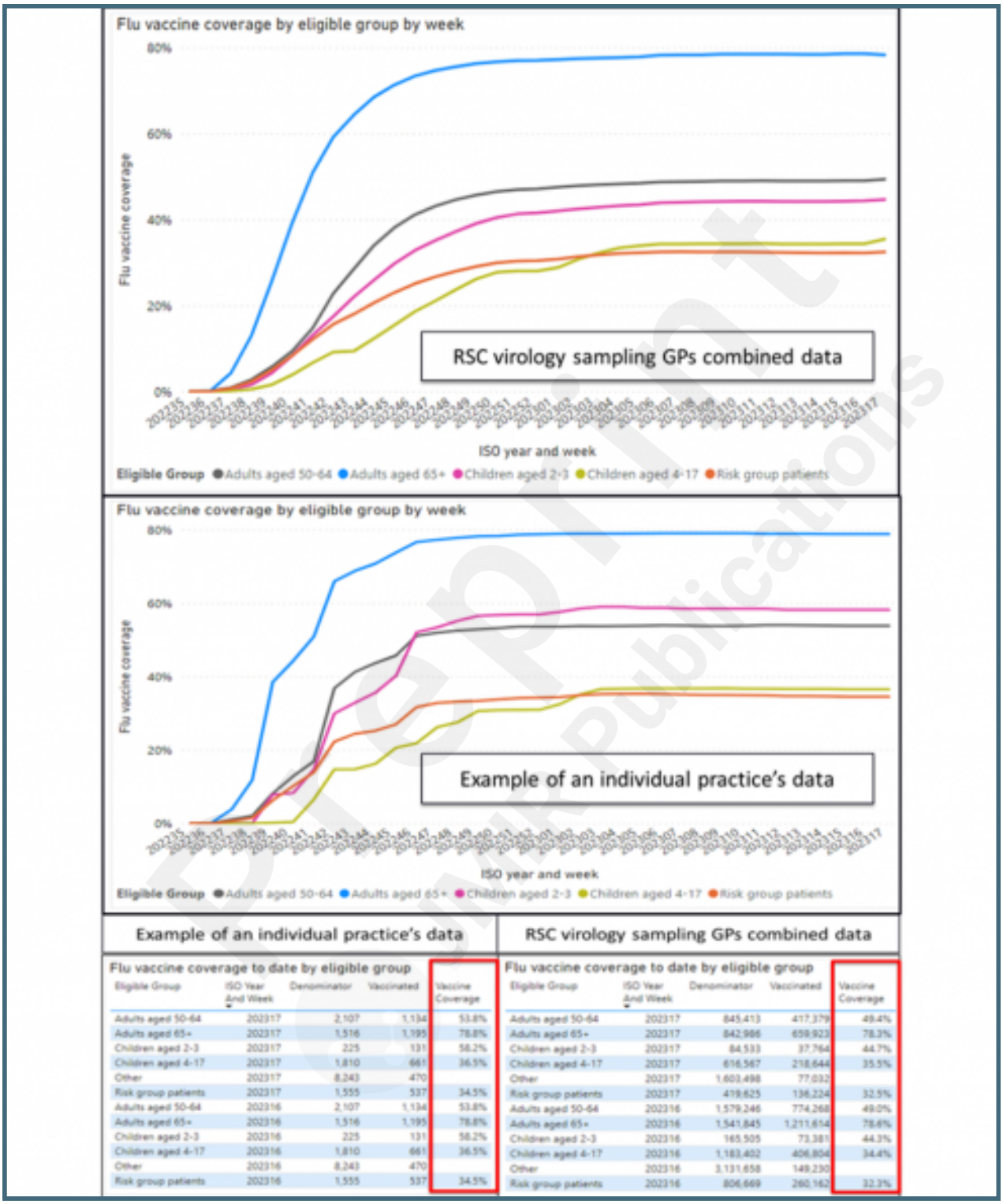
Vaccine exposure data, taken from our observatory, displaying graphically as well as numerically practice levels of vaccine uptake (2022-2023 season).



Example of an individual practice's data

Flu vaccine coverage to date by eligible group

Eligible Group	ISO Year And Week	Denominator	Vaccinated	Vaccine Coverage
Adults aged 50-64	202317	2,107	1,134	53.8%
Adults aged 65+	202317	1,516	1,195	78.8%
Children aged 2-3	202317	225	131	58.2%
Children aged 4-17	202317	1,810	661	36.5%
Other	202317	8,243	470	
Risk group patients	202317	1,555	537	34.5%
Adults aged 50-64	202316	2,107	1,134	53.8%
Adults aged 65+	202316	1,516	1,195	78.8%
Children aged 2-3	202316	225	131	58.2%
Children aged 4-17	202316	1,810	661	36.5%
Other	202316	8,243	470	
Risk group patients	202316	1,555	537	34.5%

RSC virology sampling GPs combined data

Flu vaccine coverage to date by eligible group

Eligible Group	ISO Year And Week	Denominator	Vaccinated	Vaccine Coverage
Adults aged 50-64	202317	845,413	417,379	49.4%
Adults aged 65+	202317	842,986	659,923	78.3%
Children aged 2-3	202317	84,533	37,764	44.7%
Children aged 4-17	202317	616,567	218,644	35.5%
Other	202317	1,603,498	77,032	
Risk group patients	202317	419,625	136,224	32.5%
Adults aged 50-64	202316	1,579,246	774,268	49.0%
Adults aged 65+	202316	1,541,845	1,211,614	78.6%
Children aged 2-3	202316	165,505	73,381	44.3%
Children aged 4-17	202316	1,183,402	406,804	34.4%
Other	202316	3,131,658	149,230	
Risk group patients	202316	806,669	260,162	32.3%

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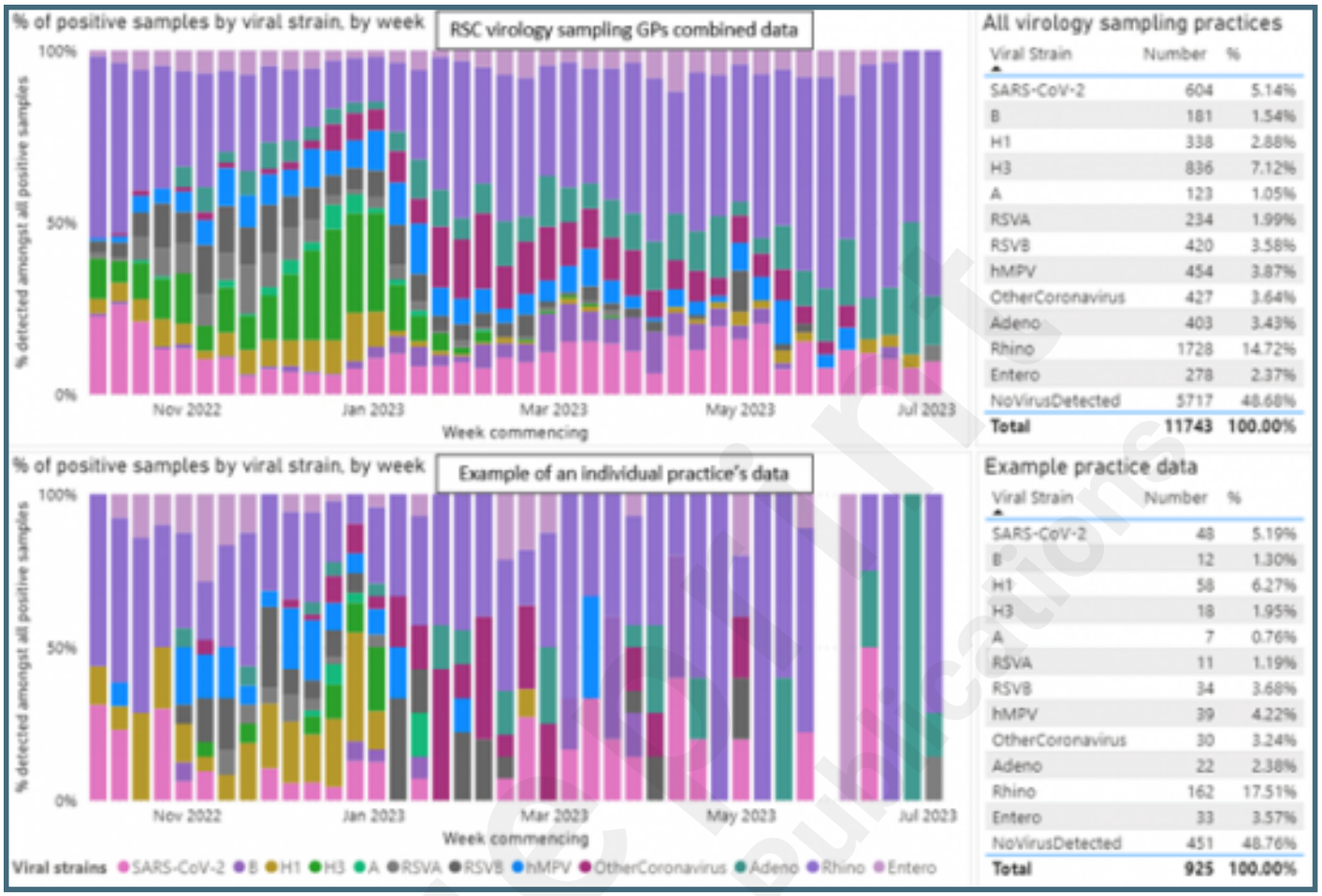
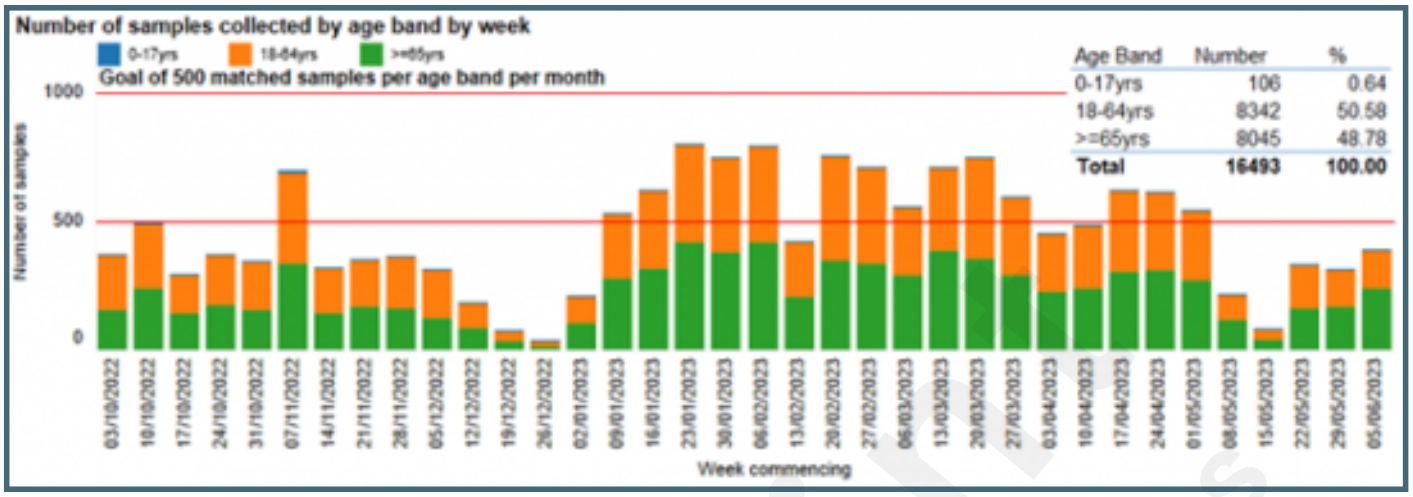
Circulating virology data, taken from our observatory, displaying the % positive samples by viruses for RSC GP's combined and an example individual practice (2022-2023 season).



Serology data, taken from our observatory and dashboard, displaying the number of samples collected by age band for RSC GP's combined (2022-2023 season).



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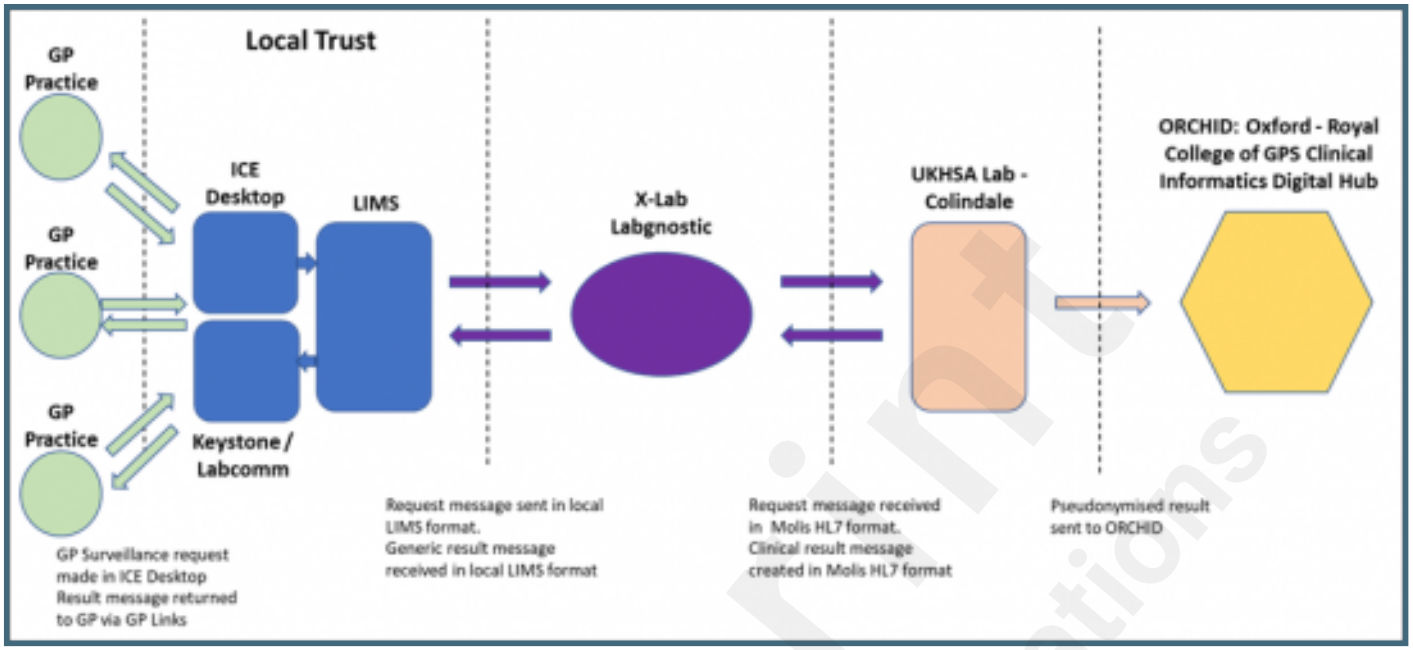
Virological surveillance data workflow. Samples are taken in practice; they pass through the local pathology laboratory to the UKHSA viral reference laboratory at Colindale. Virology results go back to the GP and patient and also into the RSC database.



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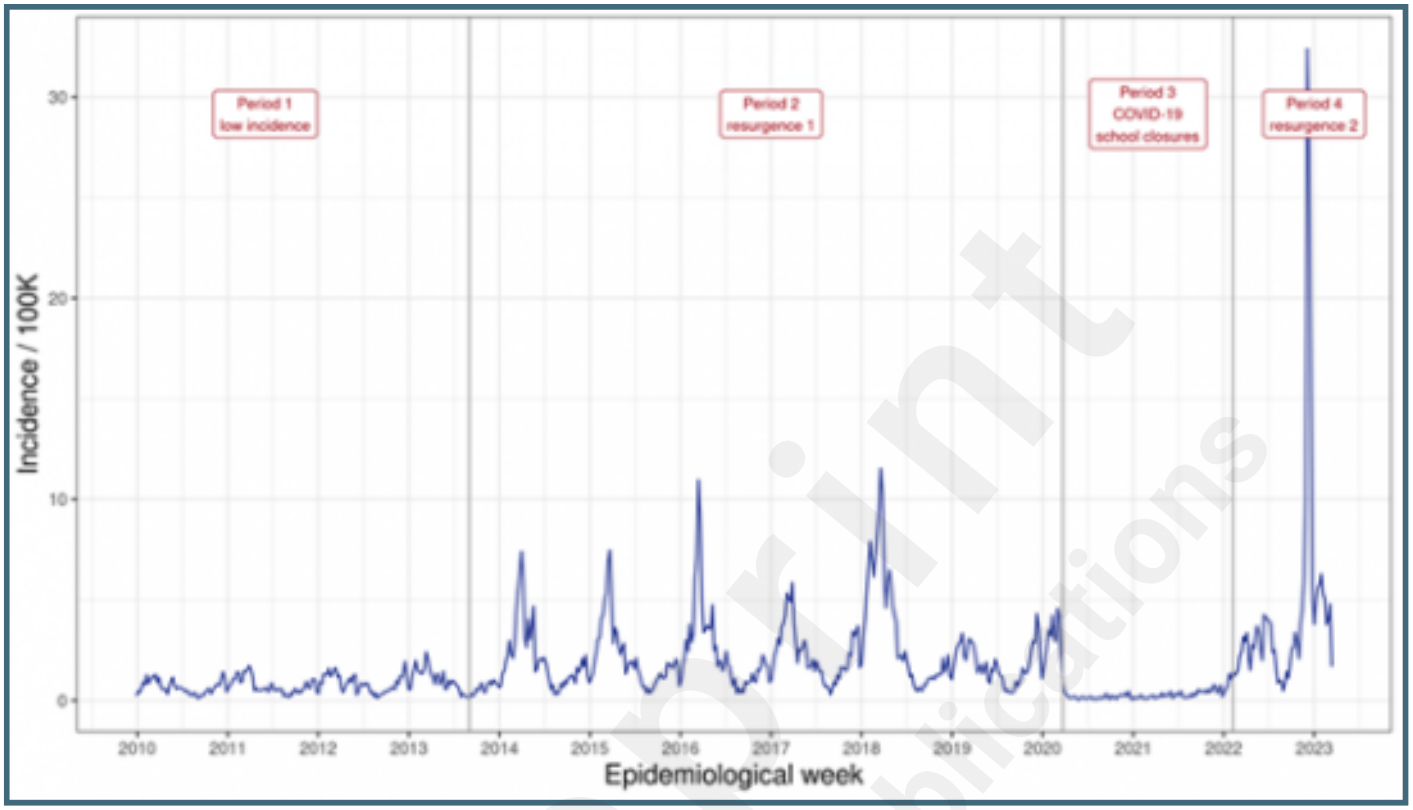
Weekly incidence of scarlet fever or Streptococcal sore throat presenting to the English primary care sentinel network practices 2010 to 2023. The incidence in the last quarter of 2022 was higher than that seen in the previous 10 years.



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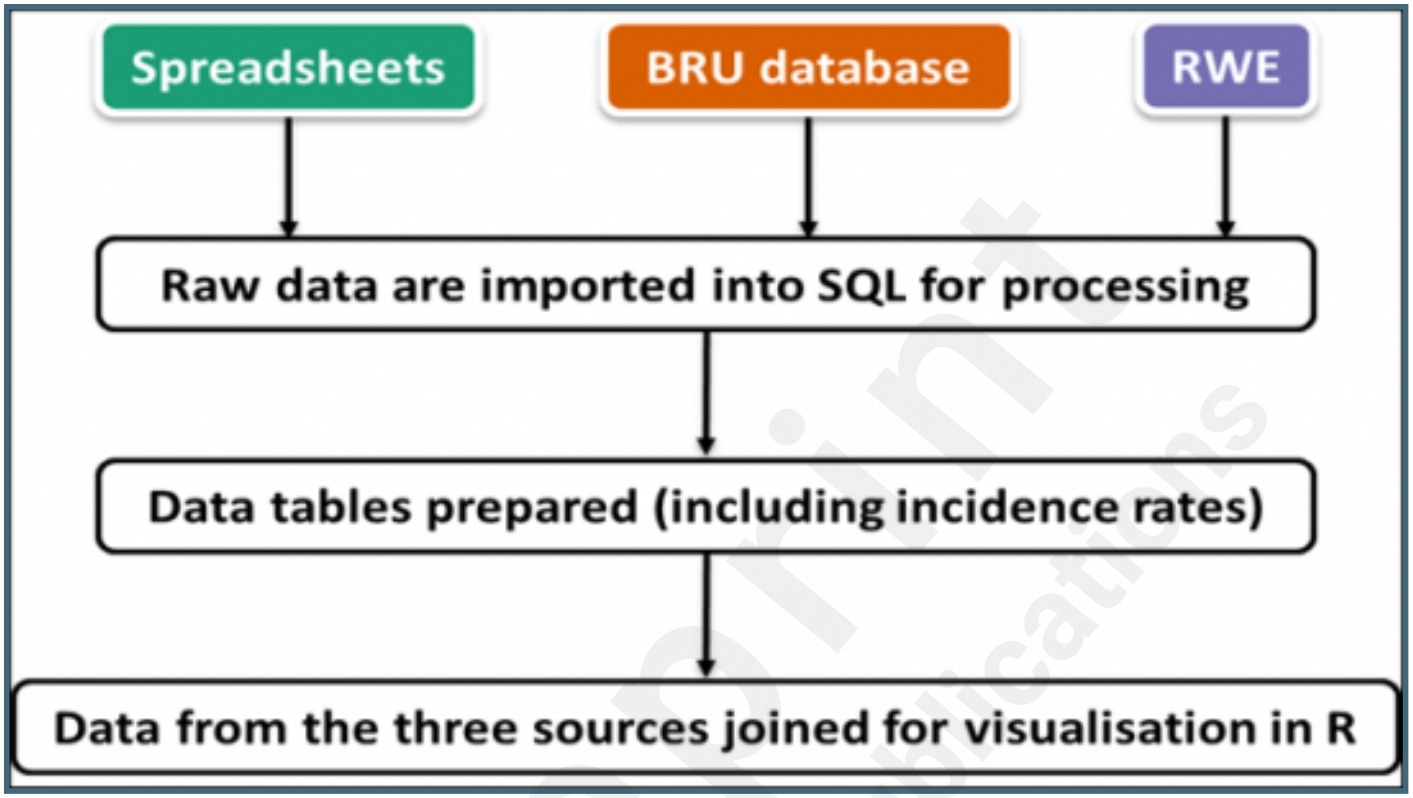
How data since 1967 are assembled within the biomedical resource. BRU = Birmingham Research Unit, the location of the RSC up to 2013. Up to 1994 spreadsheets were loaded into an Access database, this was then replaced by structured query language (SQL). RWE = Real World Evidence server, set up in 2013.



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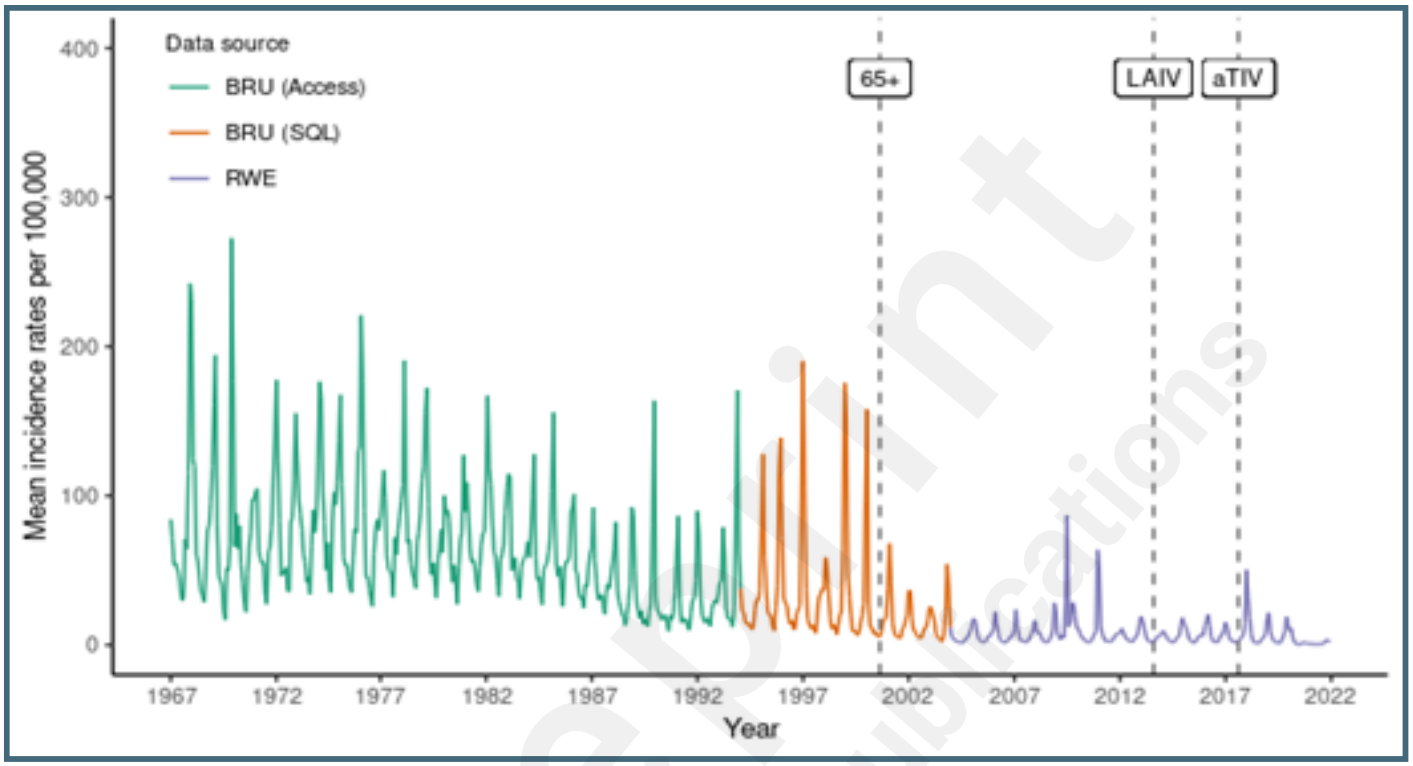
Change in the rate of presentation of ILI to primary care from 1967 to 2022. The year of introduction of different flu vaccines has been added, data are four weekly averages 65+ = introduction of flu vaccine for all aged 65 years and over LAIV = Live attenuated influenza vaccination, this was introduced for school children aTIV = adjuvanted Tri-valent influenza vaccine, introduced to improve VE in people 65 years old or older.



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Multimedia Appendixes

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Patient and public involvement - Images from the first monthly newsletter.
URL: http://asset.jmir.pub/assets/58870176276a711b13eb52db1f6880fa.docx

Coding Virology Swab Results.
URL: http://asset.jmir.pub/assets/7bf250ebbd732d44cec674b09dd21468.docx

Proposals for the vaccine effectiveness studies for the coming season.
URL: http://asset.jmir.pub/assets/657851568039620e130aeb36e8aa0657.docx

Distribution of virology and serology sampling practices and the entire network.
URL: http://asset.jmir.pub/assets/051c527b3bd1e60f500ca7953d2155f3.docx

Practice Liaison Team Communications.
URL: http://asset.jmir.pub/assets/7cb31727a9fc5bf335b6c7b196538c4f.docx

Summary of Pilot Study to Introduce Training in Paediatric Phlebotomy Training in the RSC Network, by region.
URL: http://asset.jmir.pub/assets/0ac7f520a6c39b7ffda65269269d4074.docx

An introduction to LabLinks.
URL: http://asset.jmir.pub/assets/d1b835f2e4c4d6defb31f77f812367d9.docx

A protocol for a study using point-of-care testing.
URL: http://asset.jmir.pub/assets/1665c50f6b02fef1fe383b96955933c0.docx

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