



The role of the Health Protection Agency in the ‘containment’ phase during the first wave of pandemic influenza in England in 2009

**Health Protection Agency
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Contents

- 1 Summary
- 2 Introduction
- 3 Background and chronology
- 4 Preliminary assessment of the impact of the ‘containment’ measures on the transmission of influenza in England based on surveillance data and modelling.
- 5 Operational aspects of the implementation of the ‘containment’ phase for the Health Protection Agency (HPA)
 - Coordination of the HPA response
 - Centre for Infections
 - Local and Regional Services
 - Regional Microbiology Network
 - National Institute of Biological Standards and Control
- 6 Conclusions and key lessons learned
- 7 Acknowledgements
- 8 Appendices
 - 1 Descriptive epidemiology of the pandemic in England during the period that ‘containment’ measures were applied
 - 2 Surveillance systems for influenza activity in England
 - 3 Glossary

1.0 Summary

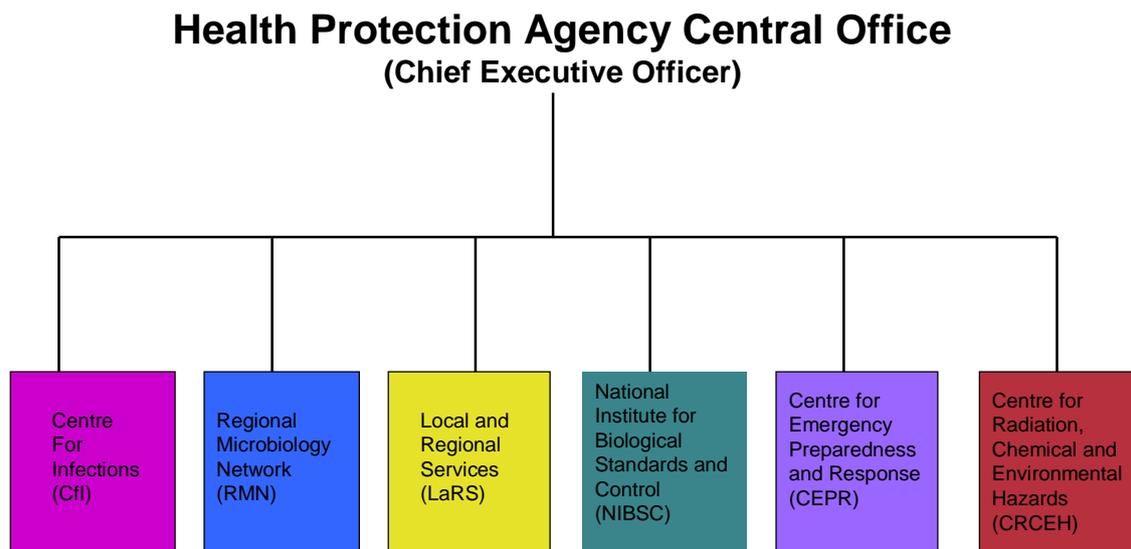
- When pandemic influenza A H1N1 emerged at the end of April 2009, there was uncertainty about its severity and the impact of the illness associated with it. Some of the initial reports caused considerable concern. It was therefore appropriate for the UK to instigate a robust public health response
- Despite extensive pandemic preparedness, countermeasures such as pandemic specific vaccine, were unlikely (and had never been likely) to be available for six months or more.
- Measures to attempt to slow the spread of the pandemic in England (labelled 'containment'), and buy time for the development of countermeasures, were judged to be appropriate.
- Through surveillance, monitoring and advice, the Health Protection Agency (HPA) worked with the Civil Contingencies Committee, Department of Health, and National Health Service (NHS) to ensure an informed, effective and coordinated approach.
- Containment measures, implemented by the HPA working with the NHS, were demonstrated to be very effective in households, and have some protective effect in other settings in which they were applied. These measures were not expected to prevent the possibility of transmission in the community and, during May and June, an increasing number of cases were identified with no links to other known cases.
- Although severe illness, and deaths, occurred in a minority of cases, especially in children and young adults and particularly in those with conditions placing them at high risk of the complications of influenza, most cases experienced a mild illness or no symptoms at all.
- During June, mounting evidence of sustained community transmission suggested that the benefit of containment measures was increasingly doubtful, and preparations were made to move to a treatment only approach.
- There is insufficient information at present to draw firm conclusions about the effectiveness of the measures taken during the containment phase to slow the spread of infection in the population or to affect the ultimate size of the first wave of the pandemic in England which peaked in late July.
- The HPA mounted a substantial sustained and coordinated emergency response throughout the containment period, including the provision of advice to professionals and the public. This phase involved a novel care delivery system for patients with influenza that had not been part of previous planning. The demand placed on the HPA during this period was considerable and HPA resources needed to maintain the containment approach became stretched, particularly towards the end of this phase.
- Further detailed review of the effectiveness of the measures taken is warranted when additional information is available. Lessons learnt should be used for future planning.

2.0 Introduction

This overview surveys the role of the Health Protection Agency (HPA) in the 'containment' phase of the 2009 influenza pandemic. It gives a preliminary assessment of the effectiveness of measures taken to contain the pandemic and assesses the impact on the HPA's activities.

The overview sets the scene for the 'containment' phase, describes the early course of, and response to, the pandemic in England, and gives the results of an analysis on the impact of 'containment' on transmission of influenza infection. Key issues identified by the major operational divisions of the HPA (Figure 1) which responded to the pandemic are summarised. Finally preliminary conclusions are drawn about the overall impact of the 'containment' phase on the course of the pandemic in England, and the role of the HPA.

Figure 1. Health Protection Agency operational divisions, 2009



3.0 Background and chronology

3.1 WHO announces pandemic threat

After the identification of the first cases of pandemic influenza A H1N1 2009 in Mexico and the United States, the World Health Organization (WHO) issued an alert on 24 April 2009. On 27 April, it declared that the world was now at pandemic phase 4 indicating that human to human transmission of an influenza virus with pandemic potential had occurred.

There was uncertainty about the severity of the illness associated with the new influenza virus. Reports from Mexico suggested widespread illness with many people requiring admission to hospital, and many deaths. As a result, authorities in the United Kingdom and many other parts of the world, prepared to mount a robust, public health response to the threat of pandemic influenza in their own populations.

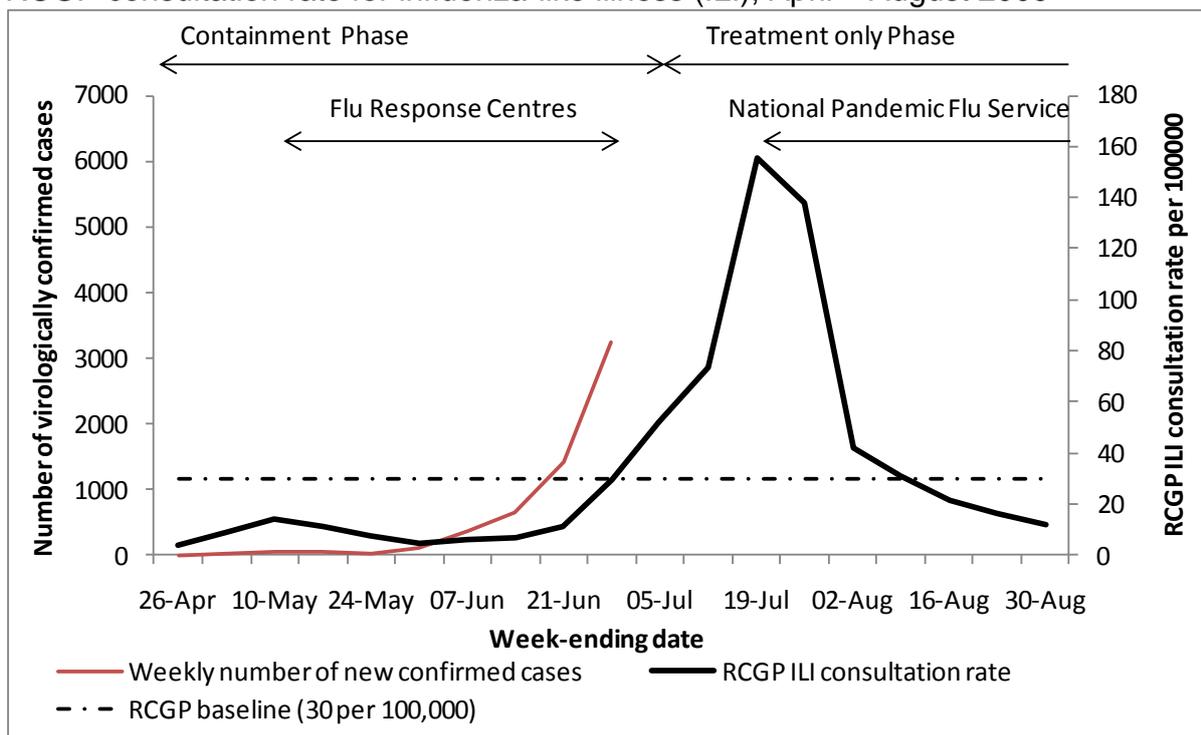
As the number of cases increased and infections were identified in other countries, the WHO moved to phase 5 on 29 April (pandemic virus identified and causing outbreaks in two or more countries within one WHO region) and to phase 6 on 11 June (pandemic virus identified and causing outbreaks in two or more WHO regions).

3.2 First cases identified in the United Kingdom

Enhanced surveillance for respiratory illness amongst travellers and close contacts of confirmed cases began in England after the first alert from the WHO. The first suspected cases of pandemic H1N1 2009 infection in the United Kingdom were reported on 26 April 2009 and confirmed on 27 April 2009. These were in two travellers returning to Scotland from Mexico, The first suspected case in England was a person who had travelled on the same flight from Mexico. The diagnosis was confirmed on 29 April along with two further cases.

A schematic overview of pandemic influenza activity in England from April to August 2009 is shown in Figure 2. A detailed epidemiological description of the course of the pandemic in England in the period 24 April to 2 July 2009 is given at Appendix 1.

Figure 2. New confirmed cases of pandemic influenza H1N1 2009 in the UK* and RCGP consultation rate for influenza-like illness (ILI), April – August 2009



* From 2 July 2009, suspected cases were no longer routinely tested for confirmation

3.3 Development of 'containment' approach in England

Further international spread of the pandemic was likely to be inevitable but a strategy of 'containment' was adopted in England with a view to minimizing secondary spread from early cases.

'Rapid containment' measures had been developed by the WHO for the early stages of a potential pandemic influenza. Using antiviral treatment for cases and antiviral prophylaxis for individuals within a restricted geographical area and isolation from the rest of the population, it was considered possible that the infection could be eliminated ('stamped out') before it spread any further. It was recognised that once more than a small number of individuals were affected, these measures were unlikely to prevent a pandemic. Once the new pandemic threat was identified in Mexico and the United States, it was clear intervention by 'rapid containment' would not be effective.

The UK's approach to 'containment' was not intended to prevent pandemic influenza, but to slow the spread of infection and buy time. The aim was to gather more information about the new threat to control it better, and to permit the development of specific countermeasures such as pandemic specific influenza vaccination. In addition, as influenza does not generally transmit within the population of the UK during the warmer months, it was possible that slowing down transmission might reduce or even avert a first pandemic wave in the summer months.

The Civil Contingencies Committee (CCC) is the UK-wide, high-level, government response group. At its meeting of 26 April, the following containment measures were agreed:

- Early detection of suspected cases by port health staff (at airports) and NHS staff (at hospitals and in primary care)

- The HPA's regional Health Protection Units (HPUs) to coordinate diagnostic sampling of suspected cases by NHS clinical staff, followed by investigation using the network of designated testing laboratories and local resources.
- Treatment of 'cases' meeting the agreed case definition (without waiting for diagnostic confirmation)
- Antiviral prophylaxis of close contacts
- Self-isolation of community cases
- Detailed investigation of cases and contacts, with follow up surveillance

Measures such as entry and exit screening for influenza at borders and the restriction of mass gatherings were judged to be of limited effect, and not introduced. Ministers agreed the containment phase at the CCC meeting of 6 May to continue until one of three triggers was reached:*

- Evidence of sustained community transmission
- Robust evidence that the disease was no worse than seasonal influenza infection
- The number of cases was so high that HPA resources, with NHS support, could not meet demand (estimated to be 3,000 cases, but later 10,000 cases).

3.4 Implementing containment in England

The initial public health response was provided by the HPA working, where appropriate, with the NHS and school authorities. Algorithms were developed that identified potential cases based on recent travel or contact with known or suspected cases. Suspected cases were assessed, specimens taken for laboratory testing, and patients were asked to stay at home (unless they needed hospital admission). Contacts of cases were identified and offered antiviral prophylaxis.

Outbreaks in schools followed introduction of the infection by pupils who had acquired infection through travel and then through contact with other cases. The usual containment phase response was to confirm cases and advise closure of school for seven days (based on the usual maximum incubation period). Those in the school with clinical illness were offered treatment with oseltamivir and only allowed to return to school when symptom free. Close contacts of confirmed cases (and of suspected cases in confirmed outbreaks) were offered prophylaxis but no restriction was placed on activity unless they became unwell. Often, contacts of cases identified in schools could not be individually identified and the whole year or school was offered prophylaxis.

3.5 Surveillance and the 'FF100' system

The HPA used formal surveillance systems and 'softer' intelligence sources from its nationally dispersed networks, to provide a coherent picture of the impact of the pandemic virus. This information was used by the Cabinet Office, Department of Health and other government departments.

Active surveillance included well established surveillance systems used in seasonal epidemics to monitor influenza activity (Appendix 2). New surveillance systems were also used. Information was collected on all laboratory confirmed cases including the likely origin of their infection.

In order to collect more detailed data on laboratory confirmed cases and their close contacts early in the first pandemic wave, the 'First Few Hundred' (FF100) surveillance project was implemented (Appendix 2). Data from this system were used to estimate how the new virus was transmitted and to assess the impact of the use of control measures (such as isolation and treatment of cases, and prophylaxis of contacts).

3.6 The development of Flu Response Centres

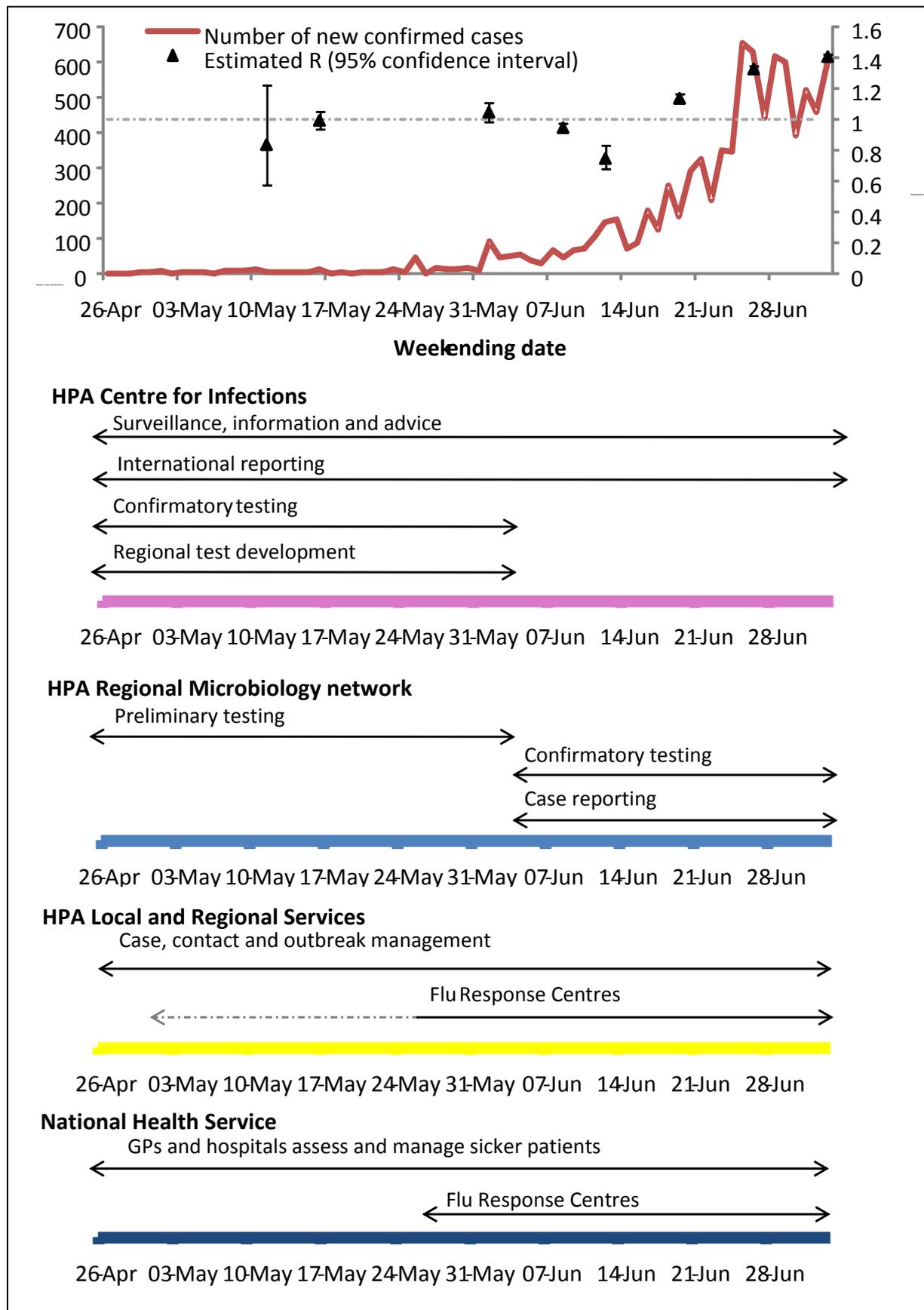
At the end of April it was agreed that the health system in England should manage the response to the first 3000 cases based on the containment approach using a regionalised call centre approach with call centres run by the HPA but jointly staffed with HPA staff and seconded NHS staff.

The first regional call centres began operation in early May 2009 and, by 27 May, 10 Flu Response Centres (FRCs) were established: one in each Strategic Health Authority. The FRCs took on much of the frontline response work initially undertaken by the HPUs. Their aim was to extend the intensive public health response and maintain public confidence by supporting the NHS. The FRCs worked with frontline NHS professionals to ensure that investigation and treatment of cases and prophylaxis of contacts was undertaken according to protocol. They also dealt with increasing numbers of queries from other organisations and from members of the public.

3.7 Case numbers begin to rise in England

The number of cases increased during May (Figure 3). By 29 May, 215 cases had been confirmed in the UK (200 in England, 14 in Scotland and one in Northern Ireland). Fifty two were reported to be cases in returning travellers, 39 in direct contacts of the returning travellers (secondary cases), 108 in others with links to the secondary cases and 8 were 'sporadic' cases with no known links to other cases (information was still being sought on the remaining eight cases).

Figure 3. New confirmed cases of pandemic influenza H1N1 2009 in the UK, estimated R value (with confidence intervals) and key HPA operational activities, April July 2009



3.8 Laboratory testing

Laboratory testing at the end of May was largely limited to ill people with links to affected countries or confirmed cases. Initially testing to confirm pandemic influenza infection was carried out at the national reference laboratory at the HPA Centre for Infections, but from 4 June confirmatory testing was devolved to the network of HPA regional laboratories (the HPA Regional Microbiology Network). This rapid decentralisation of testing capacity enabled testing of suspected cases to continue: a single laboratory would not have been able to cope.

To help gauge community transmission, data was gathered from virological testing of specimens from a subset of symptomatic patients with influenza-like illness consulting general practitioners in established virological surveillance schemes. In addition, to see how many patients seeking advice from NHS Direct had evidence of infection, a new surveillance scheme (with patients themselves taking swabs and posting specimens for virological examination) began on 28 May in collaboration with NHS Direct.

3.9 Community transmission

Cases of pandemic influenza began to be confirmed in June among patients attending general practitioner surgeries and in patients phoning NHS Direct indicating community transmission of the pandemic virus in England. This was mainly in London and the West Midlands, where there were multiple school-related outbreaks.

Data on cases and contacts were analysed by HPA mathematical modellers to estimate the case reproduction number. This number, R , is the average number of new cases by transmission from an existing case. An R above 1.0 indicates sustained population transmission and that an epidemic may occur. Although there was uncertainty around individual estimates of R , it began to approach 1.0 in late May/early June (Figure 3).

An assessment of transmission in the Birmingham area of the West Midlands compiled by the HPA in early June 2009 and presented to the government's Scientific Advisory Group for Emergencies (SAGE) on 15 June also indicated sustained community transmission in the West Midlands.

3.10 Case numbers rise further

By 22 June, the Royal College of General Practitioners (RCGP) weekly consultation rate for influenza-like illness increased above the normal baseline threshold for the first time since the pandemic's start. This level is used as an approximate indicator during winter influenza seasons that the annual period of significant influenza activity is occurring in the community. At this time the HPA estimate of R was above 1.0 (Figure 3) supporting the view that sustained community transmission was occurring.

3.11 Continuation of the containment approach

There was consideration of a change to a 'treatment only' approach in England. With a treatment only approach, ill patients would be offered antiviral treatment but prophylaxis would no longer be offered to contacts. There was considerable variation in the levels of influenza activity being reported from different parts of the country resulting in great strain on the services in the more heavily hit areas and less pressure elsewhere. The approach was relaxed for areas where there was sustained transmission of infection such as London and some areas in Birmingham at a Committee on Civil Contingencies meeting on 19 June, but containment continued in the rest of the UK.

3.12 Local modification of the containment approach

As the number of affected schools increased in June, so did the pressure on local health protection staff overseeing the containment measures, including distribution of antiviral treatment and prophylaxis. In some areas, such as London and the West Midlands the response became unsustainable and more limited measures in school outbreaks were adopted with prophylaxis restricted to close contacts only. This proved more time-consuming in practice and challenging to implement due to the need to identify individuals' movements within the school setting in order to identify all close contacts. In addition, testing of all cases became impractical and treatment on the basis of clinical illness alone began to be instituted for contacts of known cases.

As case numbers continued to rise (by the end of June nearly 7000 confirmed cases were reported), pressure on local health protection staff (including those in the HPA regional laboratories) and the staff of the FRCs escalated. During the containment phase the FRCs took over 5000 calls per day over the period of peak activity; provided antivirals to over 6000 cases and 10,000 contacts; and dealt with outbreaks in over 400 schools.

3.13 Move to treatment only

On 2 July, in view of the accumulating evidence of widespread community transmission, the Government announced that England would move to a 'treatment-only' approach. Treatment was offered to anyone reporting an influenza-like illness. Responsibility for distribution of antivirals was taken on, at this point, by local primary care services. On 23 July, the National Pandemic Flu Service came into operation. This was a telephone and internet based service that would allow the public to access antiviral treatment without being individually assessed by a health care professional.

4.0 Assessment of the impact of the containment measures on the transmission of influenza based on data from the FF100 system and modelling.

Using data from FF100 surveillance system, the impact of treatment of index cases combined with prophylaxis of close contacts with oseltamivir was analysed in two ways:

- Estimation of the reduction in the reproduction number (the average number of new cases arising due to transmission from an existing case)
- Comparison of clinical secondary attack rates in households where treatment and prophylaxis were given within 3 days of onset of symptoms in the index case compared with households where the delay was greater

Of a subset of 295 cases for whom treatment data were available, 271 (94%) reported receiving oseltamivir as treatment with a median time from onset of symptoms of 3 days. 93% of their household contacts reported receiving oseltamivir with a median time from onset of symptoms in the index case of 4 days. Most contacts received oseltamivir as prophylaxis (before the onset of symptoms, if any).

4.1 Effect on the reproduction number

Treatment and prophylaxis combined significantly reduced transmission in those who received the intervention with an estimated reduction in the reproduction number of 16%. However because there will have been no effect of treatment/prophylaxis on swine flu cases that were never detected, the reduction in the reproduction number for the whole population will have been much less than 16%.

Most cases who were treated received treatment (and their contacts given prophylaxis) several days into their infection, when estimated infectivity had already started to decline. Faster provision of treatment and prophylaxis would have reduced transmission further but may not be feasible in practice because patients delay seeking care, lab tests take time, etc.

4.2 Household clinical secondary attack rates

Preliminary data from the FF100 indicate that household contacts who did not receive anti-viral prophylaxis had a higher SAR compared to those who did (34% vs. 2%). Furthermore, the secondary attack rate was lower in household contacts where the index case had received treatment within 48 hours of onset compared to treatment after (4% vs. 11%).

4.3 Conclusions and caveats

The combination of treatment of index cases and prophylaxis of close contacts reduced symptomatic infection in close contacts, if treatment and prophylaxis were provided rapidly. The effects of treatment and prophylaxis cannot be separated, as they occurred together. Most of the effect, however, will have been due to prophylaxis as, by the time most index cases were treated (several days into their infection); their period of peak infectivity would have passed. As peak infectivity occurs close to the onset of symptoms, treatment alone is never likely to have much impact on transmission. Faster provision of treatment, but particularly faster provision of prophylaxis, would have increased the effectiveness of the intervention.

This study shows that there are important benefits of antiviral treatment and prophylaxis:

- protection of the individual; although this is dependent on the time taken to provide treatment
- protection of the close contacts of cases in the same household or in schools

Despite these benefits, if most swine flu cases in the containment phase were not detected (as seems probable in view of the estimated number of clinical cases compared with confirmed cases)), the impact of treatment and prophylaxis on the progression of the epidemic as a whole is likely to have been small.

5.0 Operational aspects of the implementation of the containment phase for the HPA

5.1 Co-ordination of the HPA response

The HPA has four national Centres and two dispersed Divisions. The Centres comprise the Centre for Infections (Cfi), based in Colindale, north London, the National Institute of Biological Standards and Control (NIBSC) based in Mill Hill, the Centre for Emergency Preparedness and Response (CEPR), based at Porton Down, Wiltshire, and the Centre for Radiation, Chemical and Environmental Hazards which has its headquarters at Chilton. The dispersed divisions are the Local & Regional Services (LaRS) and the Regional Microbiology Network (RMN). One reason for the creation of the Health Protection Agency in 2003 was to ensure an effective and co-ordinated response to threats to the health of the population through the close working of the HPA's component centres and divisions.

A National Emergency Co-ordinating Centre (NECC) was established at the central London headquarters of the HPA on 25 April 2009 to coordinate the activities in the HPA Centres and Networks in England, and to act as the point of contact with the Department of Health and the Cabinet Office. The NECC remained in operation throughout the containment phase for a minimum of 12 hours a day, seven days a week and occupied most of the meeting rooms of the HPA HQ. Staff for the NECC were drawn largely from parts of the HPA less immediately affected by the need to respond to the pandemic. As these staff were drawn from across the country, many staff were boarded temporarily in London.

The HPA worked with a wide range of other organisations to ensure a coordinated response. In particular, the agency worked with its counterpart organisations in the UK devolved administrations, and with key international bodies including the European Commission and European Centre for Disease Control and Prevention, and the World Health Organisation. Bilateral links with a number of key international partners were maintained including the Centers for Disease Control in the United States, and equivalent bodies in Canada and Australia. A small epidemiology team was dispatched to Mexico City. The agency established collaborative links with academic institutions involved in related research, and professional bodies with an interest in key groups of patients such as the Royal College of General Practitioners, the Royal College of Obstetricians and Gynaecologists, and other Royal Colleges and professional bodies, through the Pandemic Influenza Clinical and Operational Advisory Group.

5.2 Centre for Infections

The Centre for Infections is the national centre for the surveillance and control of infectious diseases. It houses many of the national bacteriology and virology reference laboratories for the United Kingdom. Working with the other divisions of the HPA, the Centre provides public health intelligence to central Government (including the Department of Health and the Cabinet Office) and the National Health Service.

The Centre for Infections Emergency Response Plan was activated on Friday 24 April 2009 after the alert from the World Health Organisation (see section 3.1). An Emergency Operations Centre (EOC) opened on Saturday, 25 April and ran continuously until 9 July 2009. The EOC supported the National Emergency Co-

ordination Centre as well as providing the focus for coordination of the work of the teams within the Centre for Infections. At the peak of the first wave approximately 90 staff at the Centre for Infections were utilised on a daily basis in responding to the pandemic

Co-ordination by the Cfi EOC

The key tasks and responses from the Centre for Infections were coordinated in two shifts by teams of 11 staff (22 staff each day), drawn from across the Centre.

Laboratory Testing

The Respiratory Virus Unit (RVU) performed testing, and the Sequencing Service Unit (SSU) provided swine flu confirmation early in the containment phase, whilst swine flu specific diagnostic and confirmatory tests were developed and validated by the RVU. Both units established shift systems to provide 24/7 testing capability to cope with the volume and urgency of work. At the peak, 100-300 specimen investigations, including confirmations, were performed each day by 3 shifts of 7 staff per shift (21 staff each day).

Vaccine development (with the HPA National Institute for Biological Standards and Control (NIBSC))

Detection of pandemic influenza virus, using diagnostic tests developed at HPA Cfi, allowed culture of clinical material from infected individuals to provide pandemic virus isolates. Virus isolates were provided from HPA Cfi to the HPA NIBSC for vaccine development (see section 5.5). Cfi also prepared and published the whole genome sequences of representative early isolates to enable the global community to compare pandemic virus strains isolated in the UK with strains from elsewhere.

Surveillance

The production of daily situation reports (SitReps) for the Department of Health and the Cabinet Office was coordinated by a team of medical and non-medical epidemiologists. This also included requests for detailed surveillance data for national advisory committees (SAGE - Scientific Advisory Group for Emergencies; SPI-M – Scientific Pandemic Influenza Advisory Committee – modelling subgroup; and JCVI - Joint Committee on Vaccination and Immunisation) to inform the national response.

Surveillance systems, including databases, were rapidly developed to collate information on confirmed or suspected cases and their contacts. The experience of Centre for Infections experts in information technology, bioinformatics, modelling, statistics and immunisation were employed to develop and operate these systems.

Syndromic Surveillance

Daily surveillance data from primary care and 'pre-primary' care systems were collated, interpreted and published by the HPA. The Real-time Syndromic Surveillance Team (ReSST), based at the West Midlands HPA produced the first daily syndromic pandemic bulletin on 27 April containing data from the NHS Direct/HPA Syndromic Surveillance System (and latterly the National Pandemic Flu Service) and the QSurveillance® GP surveillance system. ReSST has continued to produce daily syndromic bulletins during the first and second waves of the pandemic. The syndromic data produced by ReSST were used in daily SitReps; were integral for modelling teams calculating weekly national pandemic case estimates; and were provided to the CMO for national press

briefings. ReSST were also involved in the development of a community-based sampling scheme developed with NHS Direct.

International Reporting and Liaison

The Centre for Infections acts as the national focal point for international communications under the International Health Regulations (IHR) and through the EU Early Warning and Response System (EWRS). During the containment phase the Centre provided daily reports on case numbers to both WHO and to ECDC/EC, and also received and analysed data from the UK Crown Dependencies and Overseas Territories, and data received through formal (IHR, EWRS) or informal channels (websites, teleconferences) from other countries and regions. These data were fed into situation reports and briefings to DH, SAGE, etc. The centre also participated in teleconferences convened by the European Commission or WHO as required.

Communications

The HPA communications team coordinated the Agency's media response throughout this period; producing daily media updates for national and international media outlets, responding to many hundreds of media enquiries and fielding experts involved in the Agency's response for broadcast media interviews. Dedicated pages were rapidly prepared for the HPA website (www.hpa.org.uk) and regularly updated, providing information and advice for health professionals, members of the public and journalists. A 'public enquiries' team coordinated responses to hundreds of calls and online requests for advice and reassurance from members of the public.

Policy

A team of two medical consultants developed advice on policy issues, often at short notice. They also oversaw the production of clinical algorithms, advice and information documents for the public and health professionals in conjunction with the Communications team.

Clinical Advice

A team, consisting of a medical consultant and specialist registrars (doctors specialising in public health medicine or microbiology) provided clinical advice to a variety of health professionals over the telephone and initially operated on a 24/7 basis.

FF100 System

Detailed information was collected on early cases (the 'first few hundred') and their close contacts by a team of HPA staff. Cases and contacts were contacted daily for a period of seven days in order to obtain information for this system. Data collection continued until mid-July by which time information had been collected on over 390 cases and 1500 of their close contacts. The H1N1 pandemic was an opportunity to gather important data on confirmed cases and contacts and the system was, in part, developed as it went live.

Data gathering took place at Centre for Infections (CfI) using a pool of around 40 staff organised in daytime, evening and weekend shifts over a 7 day period lasting almost 12 weeks. The process of gathering information was labour intensive; the success rate of being able to conduct a telephone interview with contacts was around 45%. There was a team of between 12-14 people working 7 days per week with an emphasis on interviewing contacts outside normal office hours. Initial identification of cases was undertaken by HPA's Local and Regional Services. Support in follow-up was provided by teams of telephone interviewers at HPA Porton and Chilton.

Community based virological testing of patients reporting illness

A new, self-testing scheme was established to collect information of patients calling NHS Direct (and then the National Pandemic Flu Service). Patients who had contacted NHS Direct with symptoms were sent swabs, which once returned were tested to give an indication of rates of positivity in the symptomatic population.

Logistics

Acting under the direction of the Cfl Emergency Operations Centre, a group of up to six staff gave operational support. This included rotas, catering, travel, accommodation and maintaining the EOC infrastructure.

Procurement

There was a big increase in ordering of capital equipment and laboratory consumables. There needed to be close collaboration between laboratories and procurement. This was especially the case where shortages emerged and alternative products had to be sourced. The stores team stockpiled and distributed to the rest of the HPA seven days a week.

Safety

This was a significant activity ranging from managing risks in the laboratories to liaison with Advisory Committee on Dangerous Pathogens and Health and Safety Executive.

Real-time modelling analysis

Data from multiple surveillance sources and laboratory testing systems were synthesised in real-time using a variety of modelling techniques to estimate the reproduction number and provide scenarios for planning. Modellers from Cfl and the Centre for Emergency Preparedness and Response (CEPR) attended weekly meetings of the SPI-M modelling subcommittee from the start of the epidemic until the end of November, when the frequency of meetings was reduced. Advice was also provided directly to SAGE. Planning guidance, produced by Cabinet Office and DH, with input from HPA modellers (and academic groups from Imperial College London, London School of Hygiene & Tropical Medicine, and Warwick University), was revised several times during the epidemic as more information became available.

Examples of Key Outputs

- Development of a swine flu specific PCR (polymerase chain reaction) test and serological assays
- Timely, sensitive and accurate confirmed laboratory results and sequencing data
- Daily SitReps and surveillance data for a wide range of purposes.
- Policy and guidance documents on a broad range of topics
- Position papers to inform SAGE, SPI-M, Department of Health, Cabinet Office
- Clinical algorithms around the testing and investigation of cases
- Web guidance and information for the public and health professionals.
- International support and advice to ECDC and WHO.

5.3 Local and Regional Services

The HPA's local public health response is carried out by HPUs, which work closely with local communities and the National Health Service (Primary Care, Hospital, and Community Trusts). Within this division of the HPA there are also regional services,

covering several HPUs and co-ordinating cross boundary outbreaks and extra support to HPUs when necessary. Regional services provide important links between the HPA's centres and the local teams.

From 27 April onwards, all the HPUs of the Local and Regional Services division began receiving calls from the public and professionals about the emerging situation. Initial calls mainly related to returning travellers but, as the situation developed, the calls increasingly concerned cases and outbreaks in schools.

The volume and complexity of calls grew as demands on the HPA increased and HPU staff were involved in issues of arranging swabbing and antiviral distribution. Staff in LaRS implemented previously agreed locally appropriate plans for pandemic flu. These provided a focus for working across local partnerships (which included the NHS) in a complex and changing environment.

Operational Response

- Response before the establishment of Flu Response Centres

From 27 April HPUs had to re-prioritise their work to resource the response to flu. There was a huge volume of calls into HPUs and in some cases this was almost overwhelming. The volume of calls continued into the evening and in some cases into the early hours of the morning and this had an impact on the out of hours on call service.

In the early stages of the flu response, stocks of the correct swabs and category B packaging for use in the community were built up. Considerable pressure was placed on the laboratory arrangements for the submission of samples. A new database and questionnaire were rapidly developed to enable the collection of the important data on the early cases.

The HPA was tasked by the Committee on Civil Contingencies to identify all cases, to make arrangements for confirmed cases to receive a course of antivirals, and for their contacts to be identified and given antiviral prophylaxis. This was a novel system of delivering health care to flu patients and had not been part of the planning. It required close working between the HPA and primary care trusts, and as numbers of cases rose it became a considerable commitment.

- Flu Response Centres

In response to the Committee on Civil Contingencies' decision that containment would extend to the first 3000 cases, the HPA developed an operational plan. It was recognised that the work involved in delivering the national decision could not be managed within normal health service arrangements. Therefore a new model of service involving joint work between the HPA and NHS to develop and run regional call centres (Flu Response Centres) was devised and agreed with DH and the NHS.

The agreement to open Flu Response Centres jointly between the NHS and the HPA to manage the response to swine flu was reached over the Bank Holiday weekend 2-4 May 2009. Over the next few weeks, 10 Flu Response Centres were opened across the nine regions of LaRS. There were two Flu Response Centres in the South East and one

in every other region to mirror SHA coverage. A new data handling system was developed for the Flu Response Centres. Establishing Flu Response Centres was not part of HPA pre-pandemic planning but they were delivered by the HPA within a short time period.

The emerging pandemic wave had a much larger impact on some regions, notably the West Midlands and London, than others. All regions, however, had significant swine flu activity at this time. The information that follows illustrates the demand and the size of the response across the regions using specific examples.

West Midlands

In the West Midlands the Flu Response Centre was established on 18 May and operated extended hours seven days a week until 10 July. About 150 (whole-time equivalent) staff (excluding HPA staff overtime) were involved every day at the height of the incident, far in excess of the numbers originally specified. A total of over 13,000 calls were taken and many thousands of outgoing calls were made to and from health professionals, patients, schools and parents. HPA staff in the region worked more than 4500 hours of overtime between the end of April and 12 July, equivalent to an additional 600 working days, the efforts of these staff allowing 10,429 symptomatic people to be tested. LaRS liaised with the HPA's health and safety advisers to ensure risks associated with this demanding task were recognised and mitigated.

Despite securing more resources, the progress of the pandemic in Birmingham and the West Midlands meant that demand for the FRC sometimes exceeded capacity, and calls did not get through in time. There were also technical problems with the phone lines.

Because of a high demand from schools with influenza-like illness, a schools' cell was established in the Birmingham FRC. Although there was support from other HPUs and elsewhere, this was a new demand and the region had to change its priorities so that most of the local HPU staff were reallocated to this schools' cell. The few remaining staff dealt with schools outside Birmingham and other urgent business.

The FRC eventually consumed most of the HPU resources leaving little HPU capacity to provide additional support to local stakeholders. Staff from regional teams and from other HPA divisions based in the regions e.g. the Chemical Hazards and Poisons division also supported FRCs and regional emergency operating centres.

London

In London the HPA took over serviced offices providing a 'call centre' facility to meet the demand of calls. There were 47 desks and two smaller offices of four desks each that operated as an Emergency Operations Centre and a management office. Additional accommodation of one meeting room and two additional operational rooms (10 desks) were subsequently added.

An increase in the number of calls from 200 per week to a peak of 2200 in one day caused strain on the switchboard system, and despite increasing support and capacity, the system could not meet all the demands placed on it at peak times.

Other regions

Other regions did not experience the extreme demand seen in London or West Midlands, but there was variation in workload at other FRCs. The demand on all FRCs grew over time as the pandemic developed and FRCs increasingly drew in resources from HPUs and regional teams. In the early stages of the pandemic, keeping staff levels of the FRCs aligned with the workload was a challenge. Good local relationships developed during the pandemic flu planning process were important in ensuring this was successfully managed.

Securing sufficient NHS staff to staff FRCs adequately was also a challenge for the regions, although it became easier as the outbreak developed. When staff were available there were still significant issues to manage daily:

- the lack of continuity of staff from the NHS meant HPA staff spent a great deal of time in induction and supervision
- the competence/ability of some of the staff assigned to the FRCs was variable (inevitably given the pressure the NHS was under at the time) and steps needed to be taken to maintain the quality and governance of the system.

The opening times of Flu Response Centres varied according to local demand but there were still considerable demands on the local HPA 'on call' service.

HPA staff were determined to maintain a comprehensive professional response throughout the containment phase. Many worked long hours over many weeks to provide continuity and leadership and it was sometimes challenging to ensure that staff took adequate rest.

Treatment only phase and closure of FRCs

After the move to 'treatment only' on 2 July it was agreed that FRCs could close and the NHS would lead the national swine flu response. All the FRCs closed during the next few weeks. The HPA managed the transition with the NHS as primary care, schools and other local partners had become dependent on the advice and co-ordination provided.

Outbreak management

Outbreaks mainly occurred in schools during the containment phase and the regions were variably affected. The first two affected schools in the country were in the South West. An outbreak occurred early in the South East region associated with a large boarding school whose pupils had dispersed across the country and beyond during half term. Confirmed cases were reported in 206 schools in the West Midlands, and 239 schools in London reported cases of influenza-like illness or a confirmed case of influenza.

Schools closures were recommended on public health grounds, as part of the agreed national containment policy. This caused considerable disruption to the schools and communities and additional work for the public health teams.

HPU's were also involved in the investigation and management of cases and outbreaks of swine flu in other settings, such as prisons, and supported NHS acute hospital trusts with outbreaks in hospital settings.

Returning travellers

From 29 April until 22 May, in line with the Committee on Civil Contingencies' decision, HPA staff met all returning direct flights from Mexico at seven airports in England to offer information and reassurance. It was not considered feasible to identify passengers from Mexico entering the UK through connecting flights. After infections were reported in the United States, the CCC decided that it was not practical to identify the large numbers of passengers returning from the United States.

Flight contact tracing

During the containment phase passenger aircraft arrived in the UK with symptomatic cases on board. Contact tracing was carried out in accordance with the guideline in place at the time. At first individual Health Protection Units traced contacts but it was decided to develop a central system with standard procedures because of the number of flights and demands of liaising with the travel industry. A 'Flightdesk' service was established in the North East region which traced contacts on flights with probable or confirmed cases of swine flu during the containment phase. The service was initially provided in England and then extended to the devolved administrations in Scotland, Wales and Northern Ireland.

Flightdesk Activity

- 106 flights were discussed with flight desk
- 99 flights required the contact tracing service
- 18 different airlines were contacted
- On average there were 35-40 passengers on a flight from the exposure area
- On average UK contact information in UK was found for about a third of these passengers
- Flightdesk received regular requests from the International Health Regulation system for contact tracing of UK passengers on International flights
- SitRep and briefings were prepared on daily basis about the progress of flight contact tracing
- On one flight there were three confirmed cases sitting in different areas of plane
- There was a steady increase in the number of requests as containment progressed
- There were requests for contact tracing of 12 flights on one at the peak of activity
- The Flightdesk was, on average, notified of a case within 3 days of travel
- On average airlines supplied passenger information within 2 days.

Partner relationships

Prior pandemic planning with key stakeholders meant that overall relationships with partner organisations in the NHS, local authorities, local resilience forums and regional resilience forums were good, but required managing to different extents across the nine regions.

Partners had expectations of HPA support which were sometimes difficult to meet when HPA staff were in Flu Response Centres and dealing with outbreaks. Partners also raised with local HPA teams their concern and confusion about frequently changing algorithms and guidance.

In the West Midlands there was an early announcement by Birmingham City Council of the intention to conduct an 'Overview and Scrutiny' hearing about the response. The hearing took place on 2 July and diverted a large amount of senior HPA resource in preparation, submission and commenting on the draft report.

5.4 Regional Microbiology Network (RMN)

The RMN is a network of public health microbiology laboratories based in the English regions. RMN laboratories carry out diagnostic and public health microbiology in support of the local NHS. They link with the local LaRS and Health Protection Units as well as to the national Centre for Infections.

Measures established in response to avian influenza prepared RMN laboratories for the emergent influenza pandemic. Significant investment was made, in collaboration with the Centre for Infections, to set up an avian influenza rapid response network across the UK and Ireland, with validated laboratory tests (PCR assays) for seasonal influenza A and B and avian influenza A H5N1. All laboratories had dedicated teams available on call and able to provide a confirmed result within 4 hours of specimen receipt. The Centre for Infections ensured annual assurance of the quality of the network performance. Regular national teleconferences were conducted by the lead RMN microbiologist to assess test performance and capacity in the regional laboratories

Implementing a novel H1N1 swine influenza specific test quickly

A validated assay was developed by the Centre for Infections for the H1 component of the new pandemic virus with suitable control materials to quality assure tests. Within days of its availability the test was successfully implemented in the 8 regional laboratories.

An assay for the 'N1' component of the virus was then developed at the Centre for Infections and was similarly introduced into RMN laboratory operations.

Managing the large volume of testing in the containment phase

- testing capacity

In the first weeks of the outbreak all specimens sent to RMN laboratories could be tested and reported without difficulty. When the numbers of specimens grew, some laboratories reached their testing capacity. The RMN responded by referring specimens from these laboratories to other network laboratories. The RMN developed a planned protocol for transport and testing to maintain surge capacity. For example, the Birmingham laboratory had an arrangement with the Bristol laboratory when test requests rose from 187 in week 23 to 3003 in week 26. Similarly the Kings (London) laboratory had an arrangement with the laboratory in Cambridge when their test requests escalated from 183 in week 23 to 2018 in week 26. The RMN held

teleconferences seven days a week from late April to monitor laboratory demand and performance, and to take appropriate action to ensure that laboratory testing and reporting was performed in a timely manner. All laboratories tested several runs per day, seven days a week from early June, with run frequencies being determined by local factors. Concurrent plans were made to acquire additional automated equipment to increase testing capacity. In the last week of June, more than 10,000 tests were carried out by the RMN laboratories. In addition to testing for cases in residents of England, RMN laboratories provided support for testing for other UK areas including the armed forces based overseas.

- telephoning and communicating results

In the first few weeks of the pandemic, phoning all results was not a problem because testing numbers were low. Many telephone calls were made out of hours and at weekends to both senders and local Health Protection Units. When the volume of testing increased rapidly, providing the manpower to telephone results became a significant issue. The range of clients using the service included GPs, NHS users and the public, and there was sometimes a lack of contact details on request forms.

The regional laboratories responded by recruiting additional administrative support. Some laboratories, such as the one in Manchester, set up telephone help lines. The importance of phoning out negative results was recognised to support infection control efforts and colleagues in the Health Protection Units. This increased the daily workload.

Procurement of new equipment to increase testing capacity

When the numbers of test requests increased significantly, the RMN director of operations led an initiative to procure the appropriate equipment to enable testing in the network to function seamlessly. Procurement was achieved within weeks. When the equipment was delivered, staff were trained on it immediately. This, and extended working days, allowed the network to achieve an overall testing capacity of 5,500 tests/day.

Collaboration between the RMN network and other parts of the HPA and NHS

- nationally

There was close cooperation between RMN and the other parts of the HPA involved in responding to the pandemic. RMN was represented in all relevant teleconferences and meetings. All RMN Laboratories provided a daily spreadsheet of results to the Centre for Infections as soon as the pandemic was declared. These data enabled the HPA to produce accurate figures on the number of cases confirmed in the HPA daily Sitreps. Secondment of staff to RMN laboratories from the Centre for Emergency Preparedness and Response and National Institute for Biological Standards and Control and the London collaborating centres was arranged. Training and the development of competencies with the assays provided additional capacity for testing. NHS laboratories in Cambridge, Leicester and Leeds, and the London collaborating centres also provided additional staff.

- regionally

RMN Regional Laboratories cooperated fully with their LaRS colleagues in responding to the pandemic, taking part in regional teleconferences and meetings and working collaboratively with the Flu Response Centres when they were set up. Laboratory results were sent to Flu Response Centres at least daily and often more than once a day to facilitate rapid telephoning of results.

5.5 National Institute for Biological Standards and Control (NIBSC)

Vaccine development

Virus isolates provided by HPA's Centre for Infections and also by CDC Atlanta were used to generate pandemic vaccine candidate strains at NIBSC. As one of only three essential regulatory laboratories in the WHO global influenza network, NIBSC played a key role in the early stage of the outbreak advising on and supporting vaccine production at an international level through numerous teleconferences and meetings. In general the international network operated effectively with excellent co-operation and openness from all the partners, including manufacturers.

A candidate vaccine strain based on the CDC isolate and developed through reverse genetics was safety tested and made available from the Centre for Infections laboratory to vaccine manufacturers worldwide within 4 weeks, at more or less the same time as the first vaccine strain from CDC. The first vaccine strains had a poor vaccine yield and so the NIBSC team developed a modified strain with significantly higher yield. This strain was selected by at least one manufacturer for full scale production.

The complex process for generating vaccine candidate strains had been carefully planned and well rehearsed in the context of pandemic planning. There were some unanticipated technical hurdles, but in the event the process went well, and the new candidate strain was produced in the shortest time that had been considered possible beforehand.

Vaccine licensing

During the containment phase NIBSC also began to produce on a large scale calibrated reference materials needed for assignment of potency to vaccine batches, a critical part of the manufacturing and licensing process. These were supplied to manufacturers around the world to support vaccine development, including, at the specific request of the FDA, the United States. The NIBSC was the only laboratory in the world that was able to produce the antiserum reagent for the potency test in time to support vaccine production.

Working closely with colleagues in the MHRA, NIBSC staff also played an important role in the regulatory discussions at UK and European level about licensing of specific candidate vaccines.

6.0 Conclusions and key lessons learnt

6.1 What, in summary, was the course of the pandemic and the response during the containment phase in England?

After the identification of the pandemic threat in late April, active surveillance for potential cases was started in conjunction with a series of measures, called 'containment', aimed at slowing the spread of the pandemic in England and buying time for the development of countermeasures. The first cases in England were confirmed at the end of April and small numbers of cases were confirmed over the next few weeks. Towards the end of May, however, case numbers began to increase sharply together with outbreaks in schools. Sporadic cases (with no known links to other cases or travel) were then reported suggesting transmission in the wider community. By early June, there was evidence of sustained transmission in some areas of the country. In anticipation of a sharp rise in the number of cases, plans were being developed for a move from 'containment' to 'treatment of cases only'. The change to 'treatment only' was announced on 2 July. Case numbers continued to increase after this time peaking in late July and then falling as schools broke up for summer.

6.1 Were the objectives of the 'containment' approach achieved?

Objectives of containment

The main objective of containment was to slow the spread of pandemic influenza infection in England to buy time to:

- enable more information to be gathered on the nature of the new threat,
- provide more time for the development and implementation of measures to protect the population, including:
 - deployment of antivirals for treatment and prophylaxis
 - development of vaccine.

It was also considered possible that, with the arrival of warmer weather (when influenza transmits less efficiently), slowing of the spread of infection might combine with the warmer weather to abort a summer first wave altogether.

Case numbers increase despite containment

Despite these measures, cases were reported in returning travellers in England within a few days of the first international alerts of the pandemic threat. Cases continued to be reported in returning travellers but were increasingly reported in people infected by returning travellers or in outbreaks linked to returning travellers.

Cases also began to be recognised in individuals with no links to known cases suggesting transmission outside the circle of known cases. By early June it was becoming clear that transmission was becoming sustained in the community and was likely to lead to the occurrence of an epidemic wave. The containment approach was maintained, though with increasing difficulty in some areas until, in early July, a switch to the treatment of cases only was implemented.

Containment measures were only a small part of the factors that may have had a bearing on the course of the first wave of the pandemic in England. England's role as a major hub for international travel, the arrival into the UK of a stream of potentially infected travellers, the susceptibility of the population (particularly children and young adults), the important amplifying effect of schools, and environmental factors such as the weather, may all have played their part in the development of the first wave.

Although information is available from the work reported in this paper to indicate that, among the close contacts of cases where the cases were offered treatment and the contacts prophylaxis, some reduction in transmission of symptomatic infection occurred, the reduction was small and could only apply to those cases identified and actively managed. An increasing number of cases, however, were occurring in the community at the end of May and in early June and many were both unrecognised and untreated.

Triggers for a change from containment to treatment only

It is possible that containment measures in late April and throughout May, may have contributed to a slowing of the spread of infection in the population. It is also possible that more rigorous application of containment measures at this stage (such as the use of antiviral prophylaxis in a wider group of contacts of known cases, earlier and more prolonged closure of schools) might have resulted in an increase in the impact of containment measures at this stage (albeit at considerable cost in terms of resources and societal disruption).

A number of factors, however, meant that it would inevitably be difficult to achieve comprehensive containment. These included: multiple importations as spread occurred in a wider geographical area outside the UK; failure (despite best efforts) to detect newly imported cases fast enough or completely enough (some cases would not have fulfilled the standard case definition); amplification of case numbers in schools (before infection was recognised and controlled) and spill-over into the community; and delays in administration of prophylaxis to close contacts leading to onward transmission of infection. In addition, as symptoms in most cases were mild, many infected cases did not seek health care attention so that treatment and prophylaxis could not be applied.

It is also possible, however, that the containment measures during this period had no appreciable impact on the course of the pandemic in the population of England because infection was spreading so readily both in schools (where control measures could only be applied after at least some time had elapsed since transmission first began in the school) and in the wider population. The data from the modelling work suggests that the impact of the containment measures outside the confines of an individual household is likely to have been small. There is a strong argument, however, that at a time of considerable uncertainty about the severity of the threat, a precautionary approach with a view to achieving any amount of reduction of transmission was justified.

From early June there was increasing evidence of transmission in the wider community. This suggested that a 'containment' approach was unlikely to be effective. Arguably the containment approach should have been stopped at this time to be replaced by a treatment only approach. In addition, as June progressed, the operational aspects of maintaining a containment approach began to stretch the resources of the HPA and, in some areas, the approach was acknowledged to be unsustainable. A reduction of containment measures was introduced in these areas which increasingly approached that of treatment only.

The counter-argument was that the data supporting sustained transmission was limited and inconsistent in early June and only confirmed in later June. In the mean time, preparations were underway to ensure a smooth transition to the next phase.

6.3 Did the HPA achieve the objectives set for it and what issues arose in the implementation of the containment response by the HPA?

Coordination

The HPA mounted a full emergency response to the pandemic threat and maintained a high level of response in the containment phase and beyond. All parts of the HPA were involved in the response with particularly heavy burdens falling on the Agency's Centre for Infections, Local and Regional Services and the Regional Microbiology Network. The activities of the HPA were effectively coordinated through established emergency structures.

Plans

The HPA had pandemic preparedness plans available when the pandemic began. These plans were invaluable in developing an initial response and provided useful benchmarks for reference. Many aspects of the pandemic, however, were not anticipated in the plans (including the generally mild nature of the illness). HPA was also asked by the Committee on Civil Contingencies to implement containment measures on a wider basis and for longer than had been envisaged. Initial revisions to the HPA plans have already been incorporated into updated plans and further review of the plans will occur after the pandemic.

Guidance

Accompanying the pandemic plans was a portfolio of guidance and algorithms. These too proved useful but were changed to reflect the specific pandemic threat. In addition further changes were incorporated into the guidance and algorithms as the containment policy was revised in response to new evidence and the situation on the ground changed. Ensuring that those having to apply the latest guidance at local level were aware of changes presented some communications issues.

Dispensing antiviral drugs

HPA staff, with NHS colleagues, were involved in decisions about the administration of antiviral agents to large numbers of people. There were concerns that, although antivirals are recognised to be very safe, they are associated with side effects in some, and were being given to many people, including children, who did not have influenza. There was no previous experience of the use of these drugs on a large scale in the UK. Concern was expressed about side effects in some, particularly children, and it was recognised that there was a need to gather information on this issue to inform future policy. Nevertheless, antivirals were taken by thousands of individuals with no significant safety signal emerging from the reports received.

Pressures on local teams

HPS staff were under pressure during the containment phase and this led to questions about the timing of changes to treatment only approach. Anecdotal evidence was available from HPA staff managing cases and contacts in heavily affected areas that much additional, but unrecorded illness and transmission was occurring in the community, suggesting that containment measures might have little overall impact. In light of the evidence of the general mild nature of infection there were also concerns about maintaining the confidence of local health professionals at the local level.

Maintaining other HPA core business

With so many HPA staff responding to the pandemic, other aspects of the HPA's work had to be postponed or maintained at a minimum level. As the early pressures eased, HPA staff have been able to return to traditional priority areas of work, but some effects of this diversion of activities are likely to take longer to make up for.

Learning lessons

The organisation of the HPA response was constantly modified according to the circumstances on the ground, and as a result of lessons learnt during the early response. The HPA has established a process to ensure that all lessons learnt from the response to the pandemic (both containment and treatment only phases) are captured and used to inform the development of future response plans.

6.4 What more needs to be done to assess the potential use of a containment response in the future?

Detailed assessment

The full impact of the first wave of the pandemic in England will require detailed examination of data from surveillance systems and other data only now beginning to become available. These more recent data include assessment of the levels of infection that occurred in the population during the first (and second) waves based on serological testing of population based samples, and the linking of these data to evidence of clinical illness in the population. Comparison of pandemic's impact on severe disease and mortality with seasonal epidemics, will also contribute to this assessment.

Other countries

Other approaches to management of the pandemic were adopted by other countries. Despite differences in the precise circumstances of two countries, comparing information from countries adopting different strategies may yield useful insights into the UK approach.

Modelling

In a pandemic, modelling to explore approaches to interventions cannot always have the data needed to estimate key parameters fast enough. The primary UK data sources, available in real time, were numbers of symptomatic cases seeking care, but interpretation of these data to inform modelling requires knowledge of:

- the proportion of infections that are symptomatic
- the proportion of symptomatic cases who seek care. There is only limited information on these issues and the second is also likely to change over time, partly in response to media reporting.

The detailed information from the experience of the first two waves of the current pandemic will provide insights which will improve models used in the future. The existence of a significant level of immunity to a new pandemic influenza virus among some groups of the population, for example, had not been considered likely when the plans were being developed. It is necessary, in a pandemic, to have baseline serology as soon as practically possible because the level of prior immunity in the population, and its age-distribution, determine the course of the epidemic, and attack rates by age.

7 Acknowledgements

The HPA acknowledges the important roles played by the NHS and central government, especially the Department of Health, the tasks undertaken by key organisations at local, regional and national levels, and the dedication of its own staff and NHS colleagues. The description in this report deliberately focuses on the roles played by the HPA, with only passing references to the roles played by others. In doing so it is not the intention to belittle the importance of others roles but to draw attention to the purpose of this report as being primarily an account of the HPA's role in the containment phase.

8 Appendices

Appendix 1

8.1.0 Descriptive epidemiology of the pandemic in England during the period containment measures were applied (24 April to 2 July 2009).

The United Kingdom (UK) was one of a small number of European countries to report significant pandemic (H1N1) 2009 activity during the 2009 summer season. There are usually low levels of influenza activity in the summer; but the introduction of a novel virus into a susceptible population resulted in significant transmission across the UK. This section describes the epidemiology of the pandemic in England during the containment phase from late April to 2 July 2009.

8.1.1 Surveillance

Influenza is not a notifiable disease in England. Monitoring pandemic (H1N1) 2009 influenza virus activity in England was achieved by extending existing seasonal influenza surveillance and introducing additional surveillance systems to determine the evolving epidemiology, the spectrum of clinical disease, and the transmission characteristics of the disease. During the containment phase a clinical algorithm, using clinical and epidemiological factors, was used to identify cases of pandemic (H1N1) 2009 and all identified cases were laboratory confirmed.

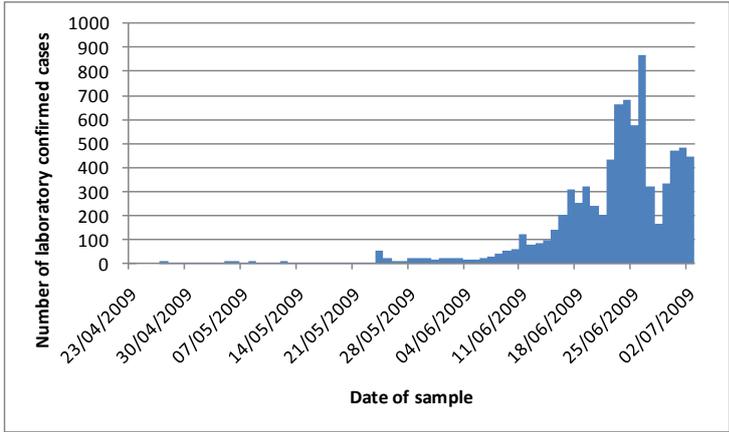
8.1.2 Epidemiology

The first suspected cases of pandemic H1N1 2009 infection in the United Kingdom were reported on 26 April 2009 in a Scottish couple returning from a trip to Mexico, and confirmed on 27 April. The first suspected case in England was also reported on 26 April in a person who had travelled on the same flight from Mexico, and confirmed on 29 April along with two further cases.

In the first four weeks of the outbreak, transmission of the infection was sporadic and was generally linked to returning travellers or to schools. By 10 June 2009, of those cases with a documented source of infection, 32% reported recent travel abroad and 40% had attended a school in which an outbreak had been confirmed. The spread of infection from schools to the community may have been made worse by late identification of outbreaks in schools; school closures a number of days after ILI outbreaks had begun; cases of illness in schoolchildren not meeting the case definition for testing; school social functions providing a source of infection; a reluctance by some parents to give their children antivirals; and limited adherence to either taking or completing the full antiviral course.

The occurrence of sporadic cases (with no links to other known cases or travel) suggested that some community transmission (i.e. transmission occurring outside the household or schools) was occurring in May. Estimates of the case reproduction number (R) exceeded 1.0 in the week 31 May to 7 June 2009, suggesting that sustained community transmission was occurring then. Case numbers increased rapidly after this time (Figure 1). The first wave lasted from late May to early September, a period of approximately 15 weeks with the peak occurring in mid July.

Figure 1: Laboratory confirmed pandemic (H1N1) 2009 cases, containment phase, England

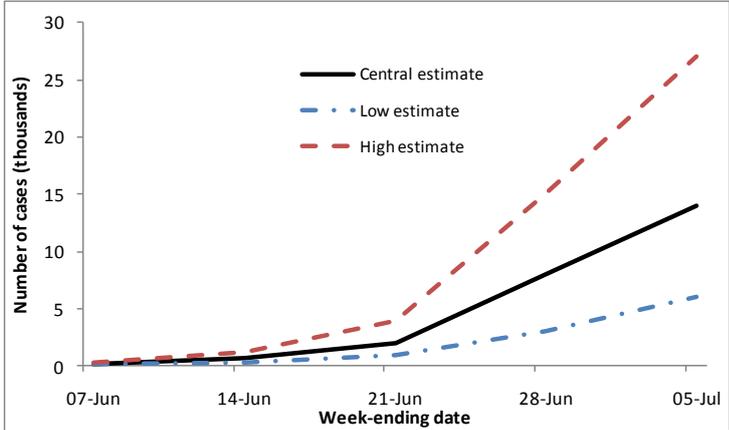


Data source: Unpublished HPA data, Datamart

8.1.3 Number of cases

During the containment phase, 8,123 pandemic (H1N1) 2009 cases were laboratory confirmed in England, a crude rate of 16 per 100,000 population. The cumulative number of symptomatic cases during this period was estimated at 25,500 (range 10,200 to 47,500), indicating that approximately one third (32%) of symptomatic cases were tested during the containment phase. The estimated numbers of symptomatic cases increased rapidly from 100 cases in the week of 1-7 June to 14,000 cases in the week 29 June – 5 July (Figure 2).

Figure 2: Estimated numbers of symptomatic cases of pandemic (H1N1) 2009, containment phase, by week, England*



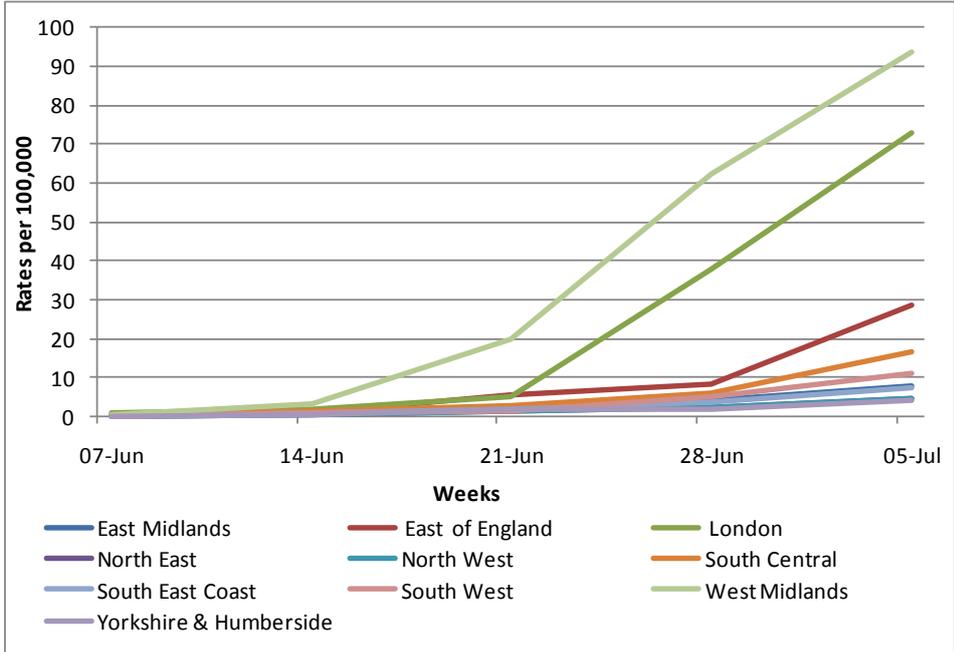
Data source: Modelling estimates

*Data to 5 July, 2009

8.1.4 Geographic spread

Cases of pandemic influenza were not dispersed evenly throughout England. London and the West Midlands SHA experienced high numbers of cases with rapid rates of increase in new cases from week to week early in the first wave. Both of these areas experienced multiple school-related outbreaks which could account for the high number of cases. Case estimates show that London and the West Midlands accounted for 39% and 35%, respectively, of clinical cases in England to the end of the containment phase (Figure 3).

Figure 3: Estimated rates of symptomatic pandemic (H1N1) 2009 cases each week, by SHA, containment phase, England



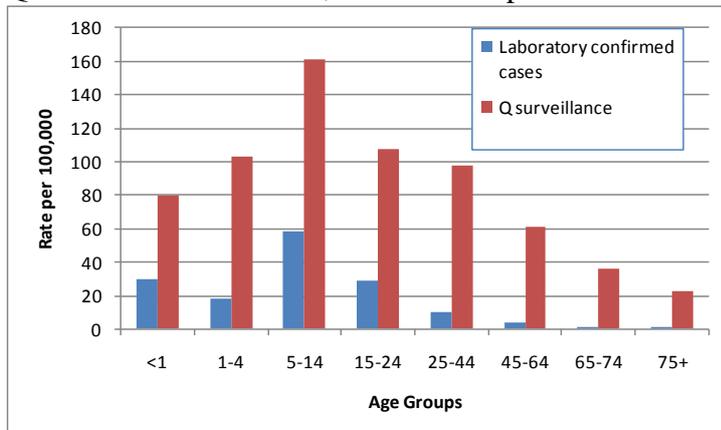
8.1.5 Age distribution

The median age of laboratory confirmed cases during the containment phase was 14 years (inter-quartile range 10-25 years). The highest age-specific rates among laboratory confirmed cases were in the 5-14 year age group (58.8 per 100,000) (Figure 4). The lowest rates were in the 75+ age group (0.5 per 100,000). This contrasts with seasonal influenza where the over-65s are more heavily affected.

Weekly consultation rates reported for the same period in the QSurveillance scheme (which records consultations for influenza-like illness with general practitioners) shows a slightly different pattern, with higher ILI rates in the 1-4 year age group than in the laboratory confirmed cases which may reflect higher testing rates in this age group (Figure 4).

This age distribution is likely to reflect past exposure to other strains of influenza A H1N1 and some level of cross protecting antibodies among older age groups. In addition, exposure opportunities through attendance at school and travel to North America may have been relatively higher for younger than older age groups.

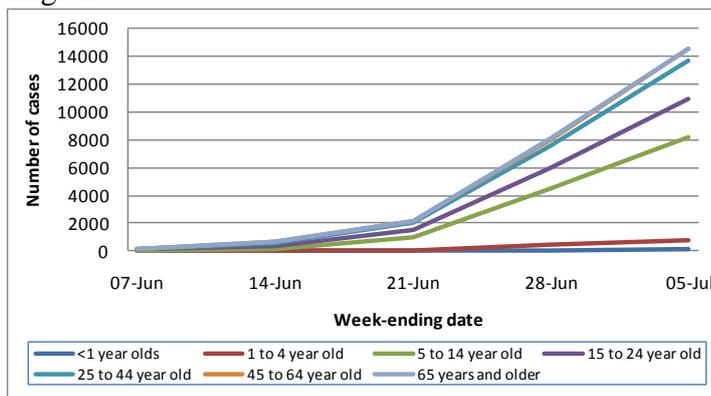
Figure 4: Age specific rates of laboratory confirmed cases of pandemic (H1N1) 2009 and QSurveillance ILI rates*, containment phase



*Note the QSurveillance data includes England, N.Ireland and Wales. Data are cumulative rates to week ending 5 July 2009.
Data source: Datamart and QSurveillance

Estimates of the numbers of symptomatic cases based on modelling indicate considerable variation by the age group (Figure 5). The highest proportion of cases were estimated to be in the 5-14 year age group (49%), followed by the 25-44 year age group (21%), 15-24 year age group (19%), 45-64 year age group (6%), 1-4 year age group (4%), the <1 year age group (1%), and the >65 year age group (0.3%). The modelled estimates suggest that the outbreak rapidly increased in those aged between 5-44 years from the week ending 21 June 2009, with much smaller increases in the other age groups.

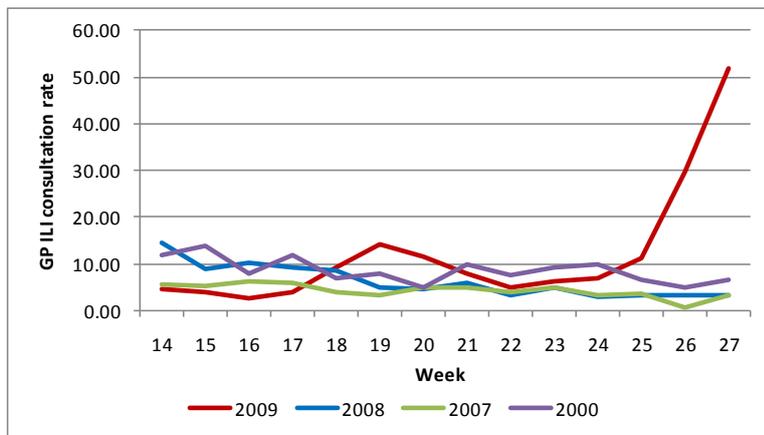
Figure 5: Estimated cases of pandemic (H1N1) 2009 by age group by week, containment phase, England



8.1.6 Comparison of rates of consultation for influenza-like illness with general practitioners from sentinel surveillance in previous years

During the containment phase, GP consultation rates for ILI increased between weeks 18 to 20, possibly due to increasing media attention on pandemic influenza, and then rapidly rose from week 25 (Figure 6). This contrasts with recent years (1999/2000, 2006/07, 2007/08, 2008/09) in which consultation rates are generally at low levels at this time of the year.

Figure 6: RCGP GP consultation rates for influenza and influenza like activity in comparison with previous years, containment phase, England



8.1.7 Clinical spectrum of disease

Most cases reported a typical influenza-like illness of generally mild severity. Detailed investigation of a subset of 373 early cases as part of the FF100 surveillance project found fever, malaise, dry cough, sore throat and headache to be the commonest ($\geq 70\%$ of respondents) reported symptoms. The median duration of illness was seven days (range 1-29 days).

Infection without symptoms is a well-recognised feature of seasonal influenza. Results of serological surveys conducted before and after the first wave of the pandemic in England suggest that considerably higher numbers of the population (particularly school age children and especially in the harder hit areas of the West Midlands and London) had evidence of infection without having been sufficiently ill to seek medical attention. HPA data indicate that 21.3% of the under 5 year group, 42% of the 5-14 year group and 20.6% of the 15-24 year group may have been infected in the first wave in London and the West Midlands (Miller E, Hoschler K, Hardelid P, Stanford E, Andres N, Zambon M. Incidence of 2009 pandemic influenza A H1N1 infection in England: a cross-sectional serological study. *The Lancet*, published online January 21, 2010). In the under 15 year group outside these two regions, the increase was 6.3%, with no significant difference in older age groups.

8.1.8 Hospitalisation

Two hundred and twenty six laboratory confirmed cases were admitted to hospital during the containment phase. The median age of hospitalised cases was 18 years. The highest numbers of cases were in the 25-44 year age group (24%). Only 8 hospitalised cases (4%) were 65 or over. The male to female ratio of hospitalised cases was 1:1.2. Sixteen (7%) of the hospitalised cases, were admitted to intensive or high dependency care.

8.1.9 Underlying illness in hospitalised cases

One hundred and nineteen (53%) of the 226 hospitalised laboratory confirmed cases had at least one underlying chronic condition (not including obesity or pregnancy). The

likelihood of a hospitalised case having a co-morbidity increased with age: only 15% of hospitalised cases aged less than 1 year had a co-morbidity whereas all hospitalised cases age 65 years and over had at least one co-morbidity. Co-morbidities included asthma (24%), other chronic respiratory disease (8%), diabetes (8%), immuno-compromise (8%), neurological conditions (7%), chronic heart disease (4%), and chronic renal problems (3%). Eleven (5%) hospitalised cases were pregnant and, where gestation was known, all were in their third trimester.

8.1.10 Deaths

There were 22 laboratory confirmed deaths from pandemic (H1N1) 2009 influenza during or shortly after the containment phase, giving a case fatality ratio of 3.2 per 1,000 cases (95% CI 2.1-4.9). No excess all-cause mortality (either overall or by age-group) was observed in England during the containment phase. The median age of cases that died was 37 years. In 18 (82%) of the deaths, there was at least one underlying risk factor (including pregnancy or obesity).

8.1.11 Types (and sub-types) of influenza viruses circulating

The pandemic (H1N1) 2009 virus was the predominant influenza virus identified during the containment phase. Small numbers of seasonal influenza A H3N2, A H1N1 and B were identified in April and May.

8.1.12 Transmission characteristics

Results of intensive epidemiological and laboratory investigation of the 'first few hundred cases' and their household contacts (FF100 surveillance project) during the containment phase were used to estimate key transmission parameters for the pandemic virus. Overall, the attack rate of illness in other household members of the virologically confirmed cases (secondary household attack rate) was 7%. In most cases, however, the contacts within the household were receiving prophylaxis with antivirals. The attack rate was approximately four times higher in children (less than 16 years) than in adults. In addition, the attack rate was 90% reduced among household contacts who received antiviral prophylaxis compared with those that did not.

During the early part of the first pandemic wave, cases in England were largely school-associated whereas, in Scotland, early clusters of cases occurred primarily among adults. Detailed investigation of three school outbreaks revealed that clinical attack rates among students ranged from 4% to 35%, but lower rates were reported among adult members of staff.

Appendix 2

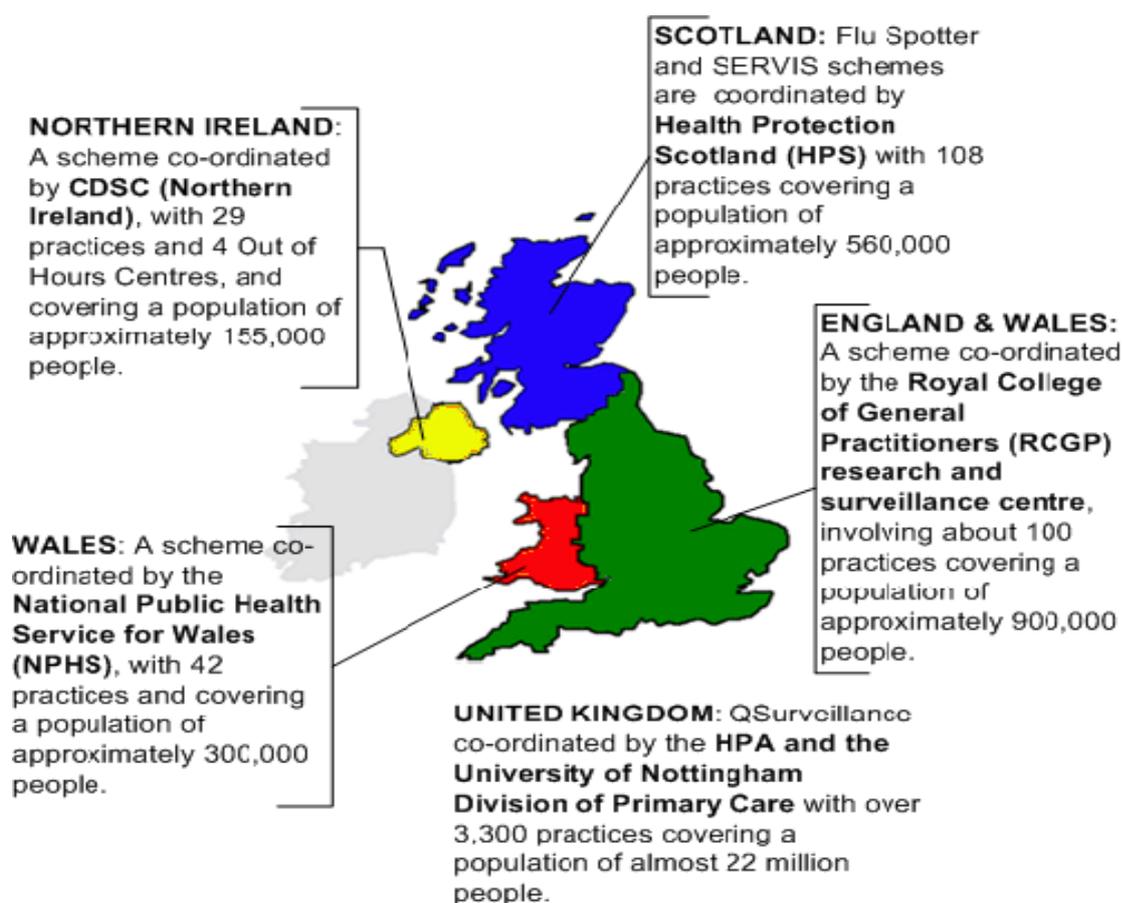
Influenza activity surveillance in England

Surveillance Methods for Influenza within the UK

1) Clinical surveillance

a) Sentinel surveillance schemes based on networks of general practitioners

Clinical data are obtained from general practitioners' (GPs) surgeries reporting weekly consultations for influenza-like illness and other acute respiratory illness. The number of patients registered with the participating general practitioners is used as the denominator.



b) QSurveillance

QFLU is a daily collection and analysis service set up by the University of Nottingham and EMIS (the main supplier of general practice computer systems within the UK) in collaboration with the Health Protection Agency. It involves over 3,300 general practices across the UK, covering a population of almost 22 million patients (> 25% of the UK population). The practices contribute daily aggregated data to a centralised database. The analyses are reported to the Health Protection Agency and its Centre for Infections and from there to the Department of Health. The QFLU dataset contains aggregated summary data for each day and each week on a series of variables.

c) Medical Officers of Schools Association (MOSA) and HPA scheme

Boarding schools in the MOSA scheme send reports of various illnesses, including influenza-like illness, to the Respiratory Diseases Department, CfI, each week during the school terms.

Up to 42 schools report, covering a population of approximately 12,000 pupils. Pupils are aged between 5 and 18 years.

d) Outbreaks of respiratory illnesses

Outbreaks in institutional setting (schools, care homes, hospitals etc.) are reported on an ad hoc basis. Cfl can provide support and advice for the management and investigation of outbreaks. Sampling to identify the virus involved is encouraged.

e) NHS Direct syndromic surveillance project

NHS Direct is a telephone helpline service that the general public can access 24 hours a day for health related enquiries. Using specific algorithms from clinical decision support systems nurses provide symptom-based advice to callers. Data on certain symptoms or syndromes are monitored with a winter focus on cold/flu and fever calls. Both the numbers of calls and ILI as a percentage of the total are monitored.

f) Mortality Data

The Office for National Statistics (ONS) provides weekly data on the number of deaths in England and Wales. These data include data from all causes and total respiratory deaths, coded using the ICD-10 coding. HPA estimates excess deaths using a statistical model, based on many years' data.

2) Laboratory surveillance

a) Virological analysis by Cfl's Virus Reference Division

The Virus Reference Division (VRD) at the HPA Centre for Infections, at Colindale provides a reference facility for subtyping and antigenic characterisation of influenza isolates on behalf of Health Protection Agency (HPA) and National Health Service (NHS) laboratories. VRD analyses about 80% of virus isolates reported in England, Wales, and Scotland.

b) Virological surveillance schemes

Two sentinel schemes provide timely information about the strains of influenza that are circulating in the population and their contribution to influenza-like illness in the community.

- Respiratory Diseases Department, Cfl, collaborative study

Eighteen Health Protection Agency (HPA) and National Health Service (NHS) laboratories in England each recruit up to four GPs to obtain nose and throat swabs from five to ten patients who present with influenza-like illness each week. Patients included for sampling should fall into one of the two categories of acute respiratory illness: 'influenza-like illness' or 'acute bronchitis', presenting within five days of onset of illness. Specimens positive for influenza are sent to the Virus Reference Department for subtyping and antigenic characterisation.

- VRD/RCGP collaborative study

Throughout the season about 50 general practices in the Royal College of GP's scheme in England obtain nose and throat swabs from patients who present with influenza-like illness and send these specimens by post to the Virus Reference Department for virus isolation and characterisation. Real-time PCR for influenza and respiratory syncytial virus (RSV) is carried out on specimens submitted from this study.

c) Routine laboratory reports from hospitals in England and Wales

Data on clinical specimens that yield positive results in tests for respiratory pathogens at regional Health Protection Agency and NHS laboratories are reported through a voluntary scheme to the Centre for Infections each week. Almost all laboratories participate. The information reported includes type of specimen, method of identification, age and sex of the patient. Some reports include additional information about cases associated with outbreaks or travel. Specimens positive for influenza are also referred to the VRD at Cfl for confirmation and further tests.

3) Systems developed in response to the pandemic influenza H1N1 2009

The above systems were developed in the following way to meet the needs to pandemic influenza (H1N1) 2009.

a) NHS Direct – self sampling by patients.

Callers to the telephone helpline within the NHS, if they had ILI, were asked if they would be willing to self swab and return nasal swab specimens in the post to the Centre for Infections at Colindale for testing. A sample of those who said they would be willing to be approached, and were 16 years of age or over, were contacted. Hence positivity rates for those contacting NHS Direct and the overall numbers in touch with NHS Direct were available for adults.

b) National Pandemic Flu Service (NPFS) – monitoring and self swabbing.

This system began only after the containment phase had ended. Callers were asked to ring NPFS if they had flu-like illness and a nurse run help-line triaged calls with those fulfilling the algorithm for likely influenza being recommended antivirals. The number of daily callers to the service was given to the HPA and formed part of its SitRep. A sample of callers aged over 16 were contacted by letter with a self swabbing kit and asked to take a nasal swab. This replaced the NHS Direct scheme from early August. A development in November 2009 was to ask parents of children between 5 and 12 years to swab their child and teenagers between 13 and 15 years to self swab (before this time only people aged 16 years or older had been contacted). Positivity rates fed into the estimation of clinical cases.

c) Overall estimate of clinical case numbers

Early in the pandemic most clinical cases were laboratory confirmed. This was in marked contrast to normal seasonal influenza. Numbers of laboratory diagnosed cases were included in early situation reports. On moving to a treatment only phase an estimation of weekly numbers of clinical cases of influenza was made on the basis of information from the various surveillance systems and an estimate of the number of patients who had clinical illness who contacted health care services. Again this only began after the containment phase had finished.

d) Enhanced excess mortality surveillance

After the start of the pandemic, the General Registry Office (GRO) for England and Wales started to provide the HPA with more detailed daily mortality data. This has allowed the HPA to estimate excess all-cause mortality by age-group in a timely fashion.

e) Mortality – follow-up

Detailed follow-up of cases who have died with/from H1N1 has been undertaken in the course of this pandemic by the CMO's office. The HPA's Centre for Infections has worked with CMO's office in the course of this monitoring and has also kept records of cases which it gets to hear about from various sources.

f) Hospitalised cases

Surveillance of hospitalised H1N1 cases has been undertaken in two ways. The HPA, together with CMO's office, has established a web-based reporting system for all acute NHS trusts in England to report laboratory confirmed H1N1 cases. This started in the second wave so was not functional in the containment phase. In addition, a sentinel system of a limited numbers of NHS Trusts collected detailed information on hospitalised cases.

g) Antiviral resistance

The HPA has been undertaking genotypic and phenotypic examination of H1N1 confirmed cases. Further epidemiological investigation has been undertaken of cases identified as oseltamivir resistant. The first cases of antiviral resistance were not identified until after the containment phase had finished.

Appendix 3

Glossary

CCC

The ministerial Committee on Civil Contingencies: a high-level inter-departmental government committee that carries out emergency planning.

CEPR

The CEPR, part of the HPA: a central source of authoritative scientific/medical information and other specialist advice in response to public health emergencies.

Cfi

The Centre for Infections, part of the HPA: carries out a range of work on the prevention of infectious disease. The remit includes infectious disease surveillance, providing specialist and reference microbiology and microbial epidemiology.

CMO

The Chief Medical Officer of the English Department of Health. The devolved administrations also have their own chief medical officers.

ECDC

The European Centre for Disease Control

EOC

Emergency Operations Centre

EWRS

Early Warning and Response System: EU system for informing member countries about threats to health posed by infections

FF100

First few hundred: a detailed study of the first few hundred identified cases of pandemic H1N1 (2009) influenza

FRC

Flu Response Centres: centres staffed by HPA staff and NHS secondees set up to implement the containment phase strategy at a regional level.

HPA

Health Protection Agency

HPU

Health Protection Units: part of the HPA's Local and Regional Services, one of whose roles is to respond to outbreaks of infectious disease

IHR

International Health Regulations: the system which ensures important information on infectious disease is passed on internationally

JCVI

Joint Committee on Vaccination and Immunisation: an expert committee that advises health ministers in the UK on vaccination policy.

LaRS

Local and Regional Services: HPA services that work alongside the NHS providing specialist support in communicable disease and infection control, and emergency planning.

NIBSC

The National Institute for Biological Standards and Control (NIBSC): a world leader in the standardisation and control of biological medicines such as vaccines and products made from blood and tissues – ensuring they are safe and effective.

ReSST

Real-time Syndromic Surveillance Team: the group based at West Midlands HPU produced daily bulletins on the pandemic.

RMN

Regional Microbiological Network: the network of HPA regional clinical and public health microbiology laboratories.

RVU

The Respiratory Virus Unit of the HPA: provides services including: diagnostic virus PCR, culture and serology; investigation of outbreaks of respiratory virus infection and genetic characterisation of respiratory viruses

SAGE

The Government's Scientific Advisory Group for Emergencies (SAGE) was established to provide cross government scientific advice regarding the outbreak of swine flu.

SPI-M

The Scientific Pandemic Influenza Advisory Committee – modelling subgroup, which included HPA experts, developed mathematical and computer models of the pandemic.

SSU

The Sequencing Service Unit of the HPA: provided swine flu confirmation early in the containment phase using nucleic acid sequencing technology.