Health Protection Scotland

NHS National Services Scotland

The Pandemic of Influenza A(H1N1) Infection in Scotland 2009-2010

A Report on the Health Protection Response

Health Protection Scotland is a division of NHS National Services Scotland.

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Health Protection Scotland
Clifton House
Clifton Place
Glasgow G3 7LN

Tel: +44 (0) 141 300 1100

Email: NSS.HPSEnquiries@nhs.net

Designed and typeset by:
Graphics Team, Health Protection Scotland

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NHS Board Strategic and Operational Leads

NHS Ayrshire and Arran

Dr Maidia Smellie, Dr Theresa Carswell

NHS Fife

Dr Charles Saunders, Dr Margaret Hannah, Mr George Brown, Pauline Small, Shona Lumsden

NHS Borders

Dr Tim Patterson, Dr Jackie Morton, Dr Tim Cameron

NHS Dumfries & Galloway

Dr D Breen, Mary Waugh

NHS Forth Valley

Dr Graham Foster, Dr Henry Prempeh, Carol Crawford

NHS Grampian

Dr Diana Webster, Fiona Browning, Laura Kluzniak

NHS Greater Glasgow and Clyde

Dr Syed Ahmed, Mr Scott Hanley, Dr Eleanor Anderson

NHS Highland

Dr Ken Oates, Abhayadevi Tissington

Golden Jubilee Hospital

Marie Smith

NHS Health Scotland

Wendy Peacock

NHS Lanarkshire

Dr David Crownie, Dr John Logan, Dr Josephine Pravinkumar

NHS Lothian

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Sara Bartram

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1 EXECUTIVE SUMMARY

On 23 April 2009, the US Center for Disease Control (CDC) confirmed the emergence of a new strain of influenza in humans, now classified by the World Health Organisation as Pandemic (H1N1) 2009 which is referred to in this report as influenza A(H1N1). This had been detected in seven patients in California and Texas. It was suspected that there had been human to human transmission. Health authorities in Mexico also reported 120 confirmed cases of respiratory illness due to influenza, 20 of whom died.

On the 26 April 2009, two Scottish holiday makers, resident in the Forth Valley board area, returned from Mexico with respiratory symptoms. They attended their GP and were suspected of having been infected with the new strain of influenza. They were hospitalised in suitable isolation facilities at Monklands Hospital, Airdrie. They were confirmed to have influenza A(H1N1) infection on the 27 April, the first in the UK. Health Protection Scotland rapidly implemented enhanced surveillance of cases and their contacts. NHS Forth Valley initiated containment of the spread of infection.

On the same date as the Scottish cases were confirmed, confirmed cases were reported in Canada, Spain, New Zealand and Israel. The World Health Organisation declared Pandemic Phase 4. With further cases being detected, WHO declared Phase 5 on the 29 April 2009. On 1 May 2009, it was confirmed that the first person to person transmission in the UK had occurred in NHS Forth Valley when an identified contact of one of the confirmed cases was also diagnosed as having been infected. By this time, it was becoming clear that the infection was rapidly being seeded across the world, affecting North and South America, Europe, Asia and Australasia.

In accord with the pandemic response framework, the UK started taking forward a strategy to slow the spread of the virus and to gather more information about it and the illness it caused. This was known as the containment phase composed of the flowing main measures:

- laboratory testing of those suspected of having contracted influenza A(H1N1);
- antiviral treatment of cases meeting the agreed case definition;
- contact tracing, and prophylaxis of close contacts;
- closure of schools based on expert advice;
- self-isolation of cases in the community;
- detailed investigation of cases and contacts.

Figure 1 presents the time line for the salient events of the containment phase.

From 1 May 2009 onwards, the infection spread through the country mainly affecting areas around the Clyde Estuary. Significant clusters of cases occurred in Greenock, Dunoon, Paisley and latterly the South-west of Glasgow. Cases were mainly managed at home but a number were hospitalised.

The World Health Organization Pandemic Alert Level was raised again with the declaration of Phase 6 on the 11 June 2009. On the same day, in light of growing evidence that transmission of the virus was becoming sustained in different parts of the country, the Scottish Government, announced that a 'modified approach to containment' would be adopted involving a tiered response. In areas of the country with sustained transmission, boards were to focus on the treatment of individuals with the virus and managing their contacts according to the level of assessed risk. Treatment was to be offered without testing and prophylaxis limited only to those assessed as being most at risk of having contracted the virus. Where sizeable clusters had arisen, the containment response was to be escalated through activating assistance from the Scottish Flu Response Centre (SFREC). Where there were still a small number of confirmed cases, the prior level of containment was to be maintained.

After 11 June 2009, discussions took place on the details of how measures to reduce the impact the infection, especially through offering antiviral treatment, would be rolled out. A revised approach to surveillance was developed. The Cabinet Secretary for Health & Wellbeing announced the intention to deliver a programme that will offer vaccination against influenza A(H1N1) to 100% of the population. Work commenced on planning this.

The number of cases continued to climb especially in Glasgow. Services were under pressure due to the need to swab and interview all those with flu-like symptoms. Up to 2 July 2010, 1,409 confirmed cases were reported to HPS. The majority of cases were within younger age groups with very few cases in the over 65 years age group. There was a higher proportion of cases within young adults compared to England where the highest number of cases was in pre-school and school age children.

On the 2 July, 2009, the United Kingdom as a whole, moved from the containment phase to a new treatment phase composed of the following main measures:

- cases would be identified through clinical diagnosis, not swabbing;
- cases would be offered antivirals on the clinical discretion of GPs;
- vaccination would be offered to those most at risk as defined by expert advice;
- increasing the coverage of surveillance by involving all GPs;
- ensuring preparedness of hospital services;
- contact tracing would cease.

The key events of the treatment phase are summarised in Figure 4.

In the period late June through mid-July in 2009, evidence was gathered that the virus was circulating in Scotland, albeit at low levels. There was not the same decrease in those attending their GPs with flu-like illness as observed during 2008. From mid-August 2009, the rates increased markedly, most probably because of the schools reopening. Results from testing revealed that the rise was mainly due to the influenza A(H1N1) virus. Consultation rates for influenza-like illness reached their highest levels in mid-November 2009, the peak being earlier and lower than that seen in the previous year for seasonal flu. Illness in the

community due to the pandemic strain of influenza therefore was not as widespread as that seen when 'routine' seasonal influenza strains are circulating.

As the pandemic evolved, it became clear that its impact would not be as severe as first feared. Unlike seasonal influenza, it mainly affected younger people who on the whole, had better health. However certain parts of the population were particularly at risk, especially children under 5 years of age, those with ongoing illnesses which could be complicated by the flu and pregnant women.

On 13 August 2009 the Scottish Government announced details of the clinical priority groups for phase 1 of the immunisation programme. Ministers also agreed that frontline health and social care staff workers would be vaccinated. The programme was launched in primary care on 21 October. In December 2009, phase 2 of the programme commenced with the key target group being those aged under 5 years.

To 31 March 2010, a total of 1542 individuals with confirmed influenza A(H1N1) infection were ever admitted to hospital in Scotland. A high proportion of patients were known to have underlying diseases, including chronic respiratory disease, diabetes or immuno-suppression. Fifty four pregnant women were admitted to hospital. By the same date, there had been 69 deaths with influenza A(H1N1) infection stated on the death certificate. The majority of deaths occurred in adults aged 16 years and over with the median age of death being 52 years of age (much lower than for seasonal flu). The great majority were known to have underlying medical conditions especially chronic respiratory illness, obesity and renal and liver conditions. Three deaths were in pregnant women with a further death occurring in the post-partum period. The majority of deaths occurred in NHS Greater Glasgow & Clyde area.

HPS stood down its pandemic response on 31 March 2010, the same day as the immunisation programme finished. A separate report presents the details of how this was carried out. The remaining sections of this report outline the health protection management of the pandemic in Scotland.

1.1 Recommendations

1.1.1 Management of the Seasonal Influenza Immunisation Programme

- HPS should seek to harmonise Scottish seasonal flu surveillance systems with those in other parts of the UK and ensure a common approach to coding those aged under 65 years who are in groups at increased risk of infection and need to be called fro immunisation.
- HPS should review the future shape of seasonal flu surveillance systems taking into account the lessons learned in the pandemic.

- HPS should better assess the burden of disease due to seasonal influenza (including the impact on ITUs and HDUs) and the effectiveness of interventions.HPS should review the costs and benefits of the surveillance of severe acute respiratory infections in hospital settings, in conjunction with other UK health protection organisations.
- HPS should collaborate with UK colleagues in examining factors (e.g. socioeconomic) which may explain the apparently higher case fatality rate in Scotland.
- NHS boards should establish a managed clinical network for virology.
- Scottish Government should review the need for a specialist lead laboratory for respiratory viruses in Scotland.
- HPS should determine remaining levels of susceptibility to influenza A(H1N1) in the population.
- HPS and NHS boards should contribute to the NICE review of the effectiveness of antivirals in post-exposure prophylaxis and treatment of influenza infection with particular regard to seasonal influenza thresholds and outbreak management.
- HPS should lead a review of the current respiratory precautions in infection control guidance to incorporate relevant lesson learned from the pandemic.

1.1.2 Managing a Future Pandemic or Like Event

- NHS boards should review the current and surge capacity requirements for virological services.
- Scottish Government should review the scope for and role of modelling in assessing risks to public health during the response to a major public health incident.
- Health protection organisations should develop methodologies for rapidly assessing the virulence of new and emerging organisms. Scottish Government should review how the assessment of specific risks to Scotland's health can be better incorporated into UK modelling during a major public health incident.
- Scottish Government should consider the production of 'most likely' in addition to 'worst case' scenarios in planning assumptions.
- Scottish Government in collaboration with its UK equivalents should review the cost effectiveness of the control measures put in place during the containment phase, compare them with those employed in other countries.
- HPS should link with its UK equivalents to further develop UK arrangements on achieving consensus on case management and related algorithms.

- HPS should link with its UK equivalents to review the scope for a single UK centre for dealing with complex flight/travel contact tracing and guidance on Travel/Port Health/ Offshore issues.
- Scottish Government should consider the implications of the restraining powers in the Public Health etc. (Scotland) Act 2008 legislative framework if there was a more severe pandemic.
- HPS should review the arrangements for naming contributors to published articles, considering if delays in information could impact on the response.
- Scottish Government should review scope for expanding role of web-based information and call centres in management of health protection.
- HPS should develop plans for how a large number of hits affects web-based information services and consider if public and professional-facing websites should be developed.
- Scottish Government should review the scope for local flexibility within a strategic framework during the health protection response to a pandemic or like event.
- Scottish Government should clarify the processes for policy making and implementation on de-escalating the response to a major public health incident.
- Scottish Government should develop a national list of prioritised public health programmes and activities to be maintained during a pandemic or like event.
- HPS should review and enhance the process of developing and disseminating guidance during a major incident including greater involvement of clinicians e.g. consultation with the Royal Colleges.
- HPS and NHS 24 should develop arrangements to re-establish SFREC for future pandemics and if appropriate other major public health incidents.
- Scottish Government should further develop joint working with primary care services in strategic planning. Contingency should be made for potential negotiations with GPs.
- NHS boards should review the timing of and need for multi-agency (e.g. SCG) meetings in future pandemics which may not be required depending on the severity of the outbreak.
- HPS and NHS boards should develop a common management infrastructure to be put in place including project management for managing future responses to pandemic influenza.

1.1.3 The Development of Health Protection Services in Scotland

- HPS should review the costs and benefits of establishing a serum bank versus specific serological investigation to estimate infection rates and levels of susceptibility to major infectious agents.
- Scottish Government should develop a framework for dealing with the governance and ethical issues related to outbreak investigation.
- HPS should review the scope for further developing the monitoring of mortality indicators in health protection.
- HPS should seek to strengthen the training, support and capability for field epidemiological investigations.
- Scottish Government should ensure access to molecular testing facilities is distributed more widely across NHS boards.
- Scottish Government should review the scope for expanding role of web-based information and call centres in management of health protection.
- Scottish Government should further clarify and formalise organisational roles and accountabilities for health protection especially relationship between HPS and boards.
- Scottish Government and NHS boards should develop and implement a health protection information system for Scotland.
- HPS should review the management and enhance arrangements for teleconferences.
- Scottish Government should review the capacity and resilience and mutual aid arrangements among boards.
- HPS should review the arrangements for naming contributors to published articles, considering if delays in information could impact on the response.
- Scottish Government should further clarify and formalise organisational roles and accountabilities for health protection.

Figure 1: Containment phase timeline

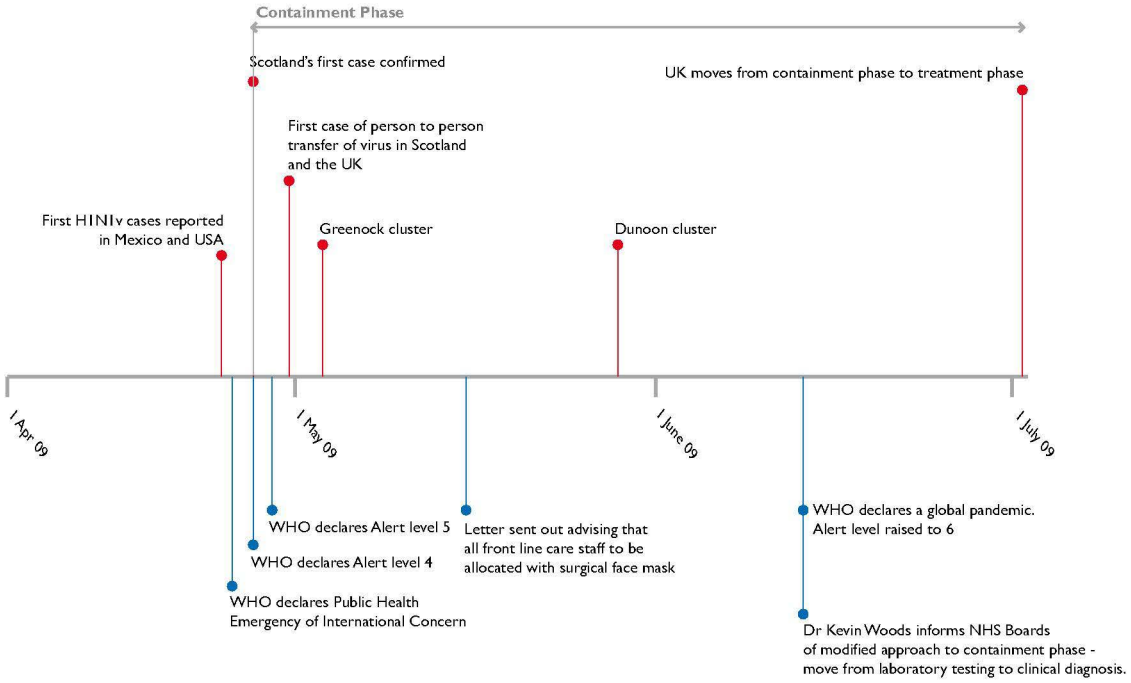
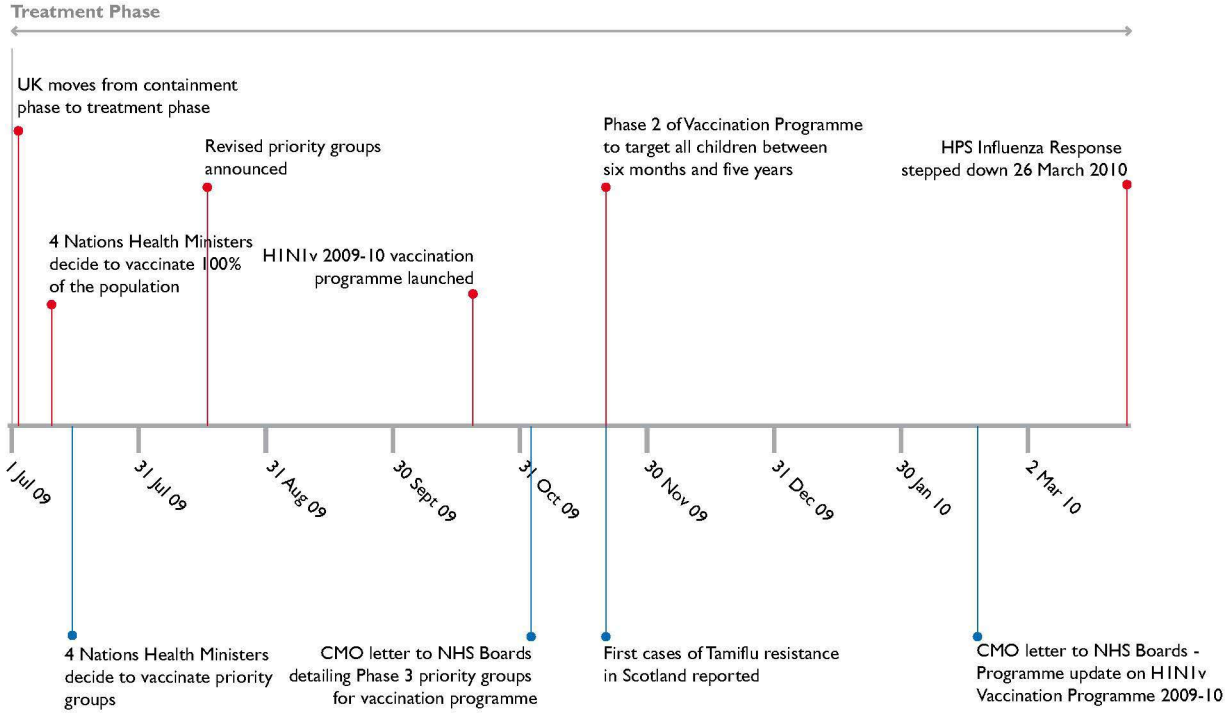


Figure 2: Treatment phase timeline



2 Introduction

2.1 Aims of Report

Health Protection Scotland (HPS), a division of NHS National Services Scotland (NSS), has produced this report to inform its parent board about the national coordination of the health protection response to the pandemic on influenza A(H1N1) infection in 2009/10. It is also to act as a reference for the management of any further like events.

In accord with guidance from the Scottish Government (SG, 2003) after a major outbreak affecting its local population each NHS board should review a report submitted to it by the team responsible for managing the response. If approved, the NHS board should ensure that the report's recommendations are forwarded to the relevant organisations with responsibility for taking them forward.

When an outbreak affects more that one NHS board area, Health Protection Scotland has responsibility for coordinating the NHS boards which manage the public health response to an outbreak locally. It does so to ensure that the response is consistent and cohesive. It has responsibility for reporting on such outbreaks. The pandemic of influenza A(H1N1) was such an outbreak.

This report sets out to:

- describe the pandemic in Scotland;
- present how it was monitored and investigated, risks assessed, control measures put in place, communications established and the health protection responders coordinated;
- indicate lessons learned;
- draw conclusions about how well objectives were achieved;
- recommend how Scotland can help improve the handling of a further pandemic or like event, the annual seasonal flu programme and health protection services in general.

2.1 Background

2.1.1 Influenza A(H1N1) Infection

The influenza A(H1N1) is a new strain of influenza virus of swine origin that first caused illness in Mexico in March and April 2009. Being a new strain, immunity to it was limited in certain sections of the population. On its appearance, it therefore had, the potential for a very rapid and widespread dissemination. After the initial identification of the virus, there was a great deal of uncertainty about its potential impact on health. Given the history of influenza pandemics during the 20th century, steps were taken to reduce the probable risks to human health.

It is now known that like seasonal flu, infection with influenza A(H1N1) may produce little in the way of symptoms (i.e. a sub-clinical infection) and can cause an unpleasant but self-limiting disease. The virus can cause severe illness in a minority of people. The groups most at risk of are those with underlying medical conditions and pregnant women.

2.1.2 Planning for the Pandemic

World Health Organisation

WHO first developed a global influenza preparedness plan in 1999 and revised it in 2005 and 2009. It set out the responsibilities of WHO and of national authorities in the event of an influenza pandemic and defined six pandemic phases (see Table 3) (WHO, 2009). The WHO would be responsible for declaring pandemic phase 6, then alert state governments (including the UK government).

Table 1: WHO pandemic phase descriptions (WHO, 2009)

WHO Phase	WHO pandemic phase description
Phase 1	No animal influenza virus circulating among animals has been reported to cause infection in humans.
Phase 2	An animal influenza virus circulating in domesticated or wild animals is known to have caused infection in humans and is therefore considered a specific potential pandemic threat.
Phase 3	An animal or human-animal influenza reassortant virus has caused sporadic cases or small clusters of disease in people, but has not resulted in human-to-human transmission sufficient to sustain community-level outbreaks.
Phase 4	Human-to-human transmission of an animal or human-animal influenza reassortant virus able to sustain community-level outbreaks has been verified.
Phase 5	The same identified virus has caused sustained community level outbreaks in two or more countries in one WHO region.
Phase 6	In addition to the criteria defined in Phase 5, the same virus has caused sustained community level outbreaks in at least one other country in another WHO region.

United Kingdom Government

The United Kingdom Government, with input from the devolved administrations, produced a strategic level pandemic preparedness framework, based on the WHO guidance. At pandemic phase 5, the UK Government would put in measures to rapidly detect, isolate and treat cases of infection and apply stringent containment measures. All close contacts of cases would be offered antiviral prophylaxis to limit the spread of the virus. It was always recognised that such internal containment efforts were unlikely to succeed totally and would be unsustainable for long periods of time.

Once the WHO had defined pandemic phase 6, the preparedness framework described four alert levels which would be activated within the UK (see Table 2).

Table 2: Description of UK alert levels 1 to 4

WHO phase 6 - UK alert levels 1 to 4		
Alert level	**Description**	**Health Protection Priorities**
1	No cases in UK	Planning, awareness raising
2	Sporadic cases in the UK	Surveillance, investigation and containment of cases.
3	Outbreaks in the UK	Reviewing initial response, infection control and securing vaccine supply
4	Widespread activity across UK	Surveillance, infection control, immunisation and identifying unexpected impacts

Depending on the nature of the illness and its effects on wider society, responses were expected from NHS clinical and public health services, governments, local authorities, voluntary organisations and caring agencies.

Scottish Government

The Scottish Framework for Responding to an Influenza Pandemic was published in October 2007 (SG, 2007). It presented the Government's overarching strategic objectives, the roles and responsibilities of the key responding agencies, the organisational arrangements for coordinating their efforts and the actions to be taken at each phase of the response. It was supported by a wide range of accompanying national planning and guidance documents.

The Scottish Government Health Department was defined as responsible for strategic coordination and overall direction of the health response in Scotland. Key decisions were to be made by Ministers within the UK Civil Contingencies arrangements designed to manage a range of national emergencies. Clearly in relation to a new virus, it was also important to keep the strategic direction of the response under a constant process of review as more evidence became available about the infection's epidemiological and clinical features and the levels and likely duration of virus circulation in the population. Advice on these was provided by UK mechanisms to obtain expert scientific advice. The main source of scientific advice was the Scientific Advisory Group on Emergencies.

NHS Boards

NHS boards' health protection remit was set out in a letter from the CMO in 2007 (CMO (2007)). To discharge it, NHS boards have to provide the following key health protection functions: surveillance, investigation; risk assessment; control measures, risk communication and incident management.

Under the 2007 Pandemic framework, NHS boards were responsible for the health and community care response. They needed to make targeted and effective use of resources, to assess and treat all symptomatic patients rapidly and to implement an immunisation programme if necessary. They were responsible for providing data to monitor the impact of interventions. They were required to liaise very closely with HPS in identifying and monitoring the first few hundred cases of the emerging virus.

Health Protection Scotland

Health Protection Scotland is a division of NHS National Services Scotland and is accountable to its parent board. Its remit during the pandemic was to ensure a consistent and cohesive health protection response in Scotland by:

- collaborating effectively with regional, national, UK and international partner organisations;
- monitoring the epidemiological and virological pattern of the pandemic;
- producing timely and accurate information and advice for health professionals, for Scottish Government and other partner organisations;
- investigating the transmission, morbidity, case fatality and broader impact of the pandemic and the effectiveness of measures to combat it;
- assessing the risk to the public and specific communities from pandemic influenza;
- facilitating measures to prevent transmission and reduce the morbidity, case fatality and broader impact of the pandemic;
- capturing lessons learnt from the health protection management of the pandemic for future reference.

To facilitate the NHS boards and HPS working together, a 'Health Protection Framework for the response to an influenza pandemic in Scotland' was developed this was aligned with the Health Protection Agency's Influenza Pandemic Contingency Plan. The framework indicated how Scottish agencies should carry out the key health protection functions at each phase of the pandemic.

2.1 Lessons Learned

In accordance with Scottish Government guidance on managing incidents, HPS led a number of exercises to define lessons learned from health protection response in Scotland to the Pandemic. These assessments were an opportunity for those involved to comment on the response, share experiences, draw from good practice and identify practical and strategic issues that need to be considered in the future.

The Scottish Directors of Public Health (SDsPH) requested that HPS undertake a structured assessment exercise in 2009 with the aims of:

- Determining lessons that could be learnt from the NHS boards' actions during the containment phase of the influenza A(H1N1) pandemic response in Scotland.
- Providing an opportunity for NHS boards to comment on the response.
- Facilitating the sharing of experience to help strengthen good practice.
- Identifying practical and strategic issues that need to be considered should a similar response be required again.
- Making recommendations to improve the planning and implementation of the health protection response to events such as a pandemic.

All 14 NHS boards public health teams were invited to participate as were NHS 24, the Scottish Ambulance Service (SAS), NSS National Procurement, the Scottish Directors of Pharmacy and the Scottish Clinical Virology Consultants Group. The survey was available online from October 2009 – March 2010.

The HPS Emergency Response Team (ERT) operated during the containment phase. It was the coordinating group established to oversee the HPS response, liaise with the Scottish Government Health Directorate and other UK health protection organisations, coordinate the 14 NHS boards and other partners including NHS 24. Given the numbers of people involved in the response, a questionnaire was sent to all HPS staff. Comments were sought on what worked well, what did not and what specific improvements could be made for future events, with regard to:

- facilities and internal management procedures;
- coordination of the NHS Scotland health protection response;
- surveillance and epidemiology;
- advice and guidance;
- immunisation;
- pandemic flu framework.

The role and activities of the HPS ERT were then passed on to the HPS Influenza Response Coordination Team (IRCT). A high degree of collaboration and co-operation with NHS boards and the Scottish Government continued into the subsequent treatment phase. A lessons learned questionnaire was sent to all members to facilitate a set of recommendations on managing future incidents at HPS which covered:

- roles and responsibilities;
- internal procedures;
- communications;
- risks and issues;
- escalation process.

In addition to the lessons learned in this report, others on the pandemic in Scotland have featured in:

- The Government's contribution to the independent review of the pandemic response jointly commissioned by all four UK administrations.
- The Government's capture of lessons learned through the civil contingencies processes.
- HPS's report on the National Vaccination Programme to protect the Scottish population from influenza A(H1N1) infection.

The key issues arising from the feedback are summarised in each section under 'lessons learned'.

3 Surveillance and Epidemiological Investigation

3.1 Background

On recognition of the first case in the UK, an intense epidemiological investigation commenced. This involved the use of the formal surveillance systems for influenza which ordinarily do not run over the spring and summer and new systems designed to gather information about laboratory confirmed cases and their contacts. In addition specific epidemiological investigations took place to describe the clusters and outbreaks occurring in the area around the Clyde estuary.

Data from these were supplied to those assessing the risk from the pandemic by computer modelling. In liaison with HPA, who coordinated the UK surveillance and epidemiological investigation, information was also submitted for consideration by SAGE. Information was also used by Scottish Government and NHS boards to help shape their response.

With the onset of the treatment phase, the priority for surveillance shifted to characterising the spread, trend and impact of the Pandemic through monitoring clinical presentations. Routine laboratory investigation of all cases ceased with analysis of only a subset of samples from those attending certain GPs or hospitalised patients.

3.2 Aims and Objectives

The aims of the surveillance and epidemiological investigation were to inform the public health and healthcare response to H1N1 infection by:

In the containment phase:

- Detecting and investigating confirmed cases and contacts to help assess the transmissibility and virulence of the infection.
- Detecting and defining clusters and outbreaks.
- Measuring the extent of illness presenting as influenza-like illness to the healthcare services and its distribution within the population.
- Reporting on the above to stakeholders.

In the treatment phase:

- Measuring the extent of illness presenting as influenza-like illness to the healthcare services and its distribution within the population.
- Defining the proportion of influenza-like illness in the community due to influenza A(H1N1).

- Estimating the severity of illness due to influenza A(H1N1) infections.
- Identifying changes to the virus particularly with respect to its transmissibility and its susceptibility to antiviral drugs.
- Reporting on the above to stakeholders.

3.3 Surveillance Systems

The surveillance systems which operated during the pandemic are summarised below. Table 3 presents the data flows and outputs.

The 10 systems are divided into groups. The first are those which were operational during the containment phase. There are six, two of which, the case investigation and the clusters and outbreaks, ceased to operate on 2 July 2009. Four systems (PIPeR, NHS 24 syndromes, sentinel swabbing and all cause mortality) operated throughout the pandemic. They were amended as required. The systems were:

a) The Case Investigation system was based on algorithms for the management of cases and contacts which had been developed as part of pre-pandemic preparedness across the UK. Using these, clinicians identified suspected cases, arranged for testing and notified the cases to public health departments which in turn notified HPS if the case was confirmed. Notified confirmed cases were then interviewed and forms were returned to HPS.

b) Cluster and Outbreak System: when a cluster was identified, additional information on cases involved was collected and analysed depending on the specifics of the clusters. Details were obtained on school closures.

c) Pandemic Influenza Primary care Reporting System (PIPeR) collected GP consultation data on respiratory illness (influenza-like illness and acute respiratory infections) from 37 practices (covering about 4% of the Scottish population). It had historical data for the preceding 6 years which enabled the comparison of the epidemiology of illness due to influenza A(H1N1) with that due to seasonal flu.

d) NHS 24 Syndrome Surveillance: Data were received from the NHS 24 telephone service, with calls being categorised into ten syndromes based on reported symptoms. Increased calls in the categories of cold/flu; fever, coughs and difficulty breathing were considered indicative of increased presentations of influenza-like illness within the community. In addition, during the containment phase data on calls mentioning 'swine- flu' were collected.

e) Daily Death totals: HPS received data from the General Register Office Scotland (GROS) for analysis of mortality due to all causes, in Scotland. Daily reporting of deaths to HPS allowed calculation of whether there was an excess in deaths compared with expected (from historical data).

f) General Practice Sentinel Swabbing for respiratory viruses: Sentinel GP practices collaborated in swabbing of patients to estimate what proportion of those presenting to their GP with influenza-like illness or acute respiratory infection had influenza A(H1N1) infection. During the containment phase, the sentinel GP practices were those in the PIPeR scheme. In the treatment phase, there was a need to extend the system to make it more representative of the Scottish population as a whole. Swabs were sent to the West of Scotland Specialist Virology Centre (WoSSVC) for testing. It was agreed that approximately 500 samples were required to generate sufficient statistical power to show significant changes in weekly proportions of positive samples for influenza A(H1N1) at an individual NHS board level.

Four additional systems were set up during the treatment phase: Scottish Influenza Surveillance Reporting Scheme, Hospitalised confirmed cases, deaths due to influenza A(H1N1) infection and antiviral prescribing.

f) Scottish Influenza Surveillance Reporting Scheme: To provide more comprehensive surveillance to enable NHS boards to monitor trends and spread in their own area, from August 2009, in line with other parts of the UK, aggregated data on consultations were automatically extracted for flu-like illness from almost all GP practices in Scotland. Standardised codes and recording were used across the UK to allow comparability between the different countries.

g) Hospitalised confirmed cases: There was no previous surveillance in place for severe presentations of seasonal flu resulting in hospitalisation. Infection Control Staff within acute hospitals were identified as best placed to collect the required surveillance data within most NHS board areas. An automated, web-based case investigation form was designed by HPS.

h) Influenza A(H1N1) associated deaths: NHS boards supplied data on individual influenza A(H1N1) related deaths based on Scottish Government criteria: death caused directly by Swine Flu (part I of the death certificate) or swine flu contributed to death (part II of death certificate) and the patient tested positive for influenza A(H1N1). Such data was subsequently validated by comparison with GROS data. The definitions were a slight variation on the definition of a confirmed influenza A(H1N1) death which was subsequently used in England and Wales. Summary information on all influenza A(H1N1) associated deaths was sent to HPA via a secure email for compilation of UK figures.

i) Antiviral prescribing information was provided for all NHS boards either from the e-Pharmacy group (13 NHS boards) or from the NHS board pharmacy team (NHS Lanarkshire) from 29 August 2009 onwards.

Table 3: Pandemic influenza surveillance systems managed by HPS

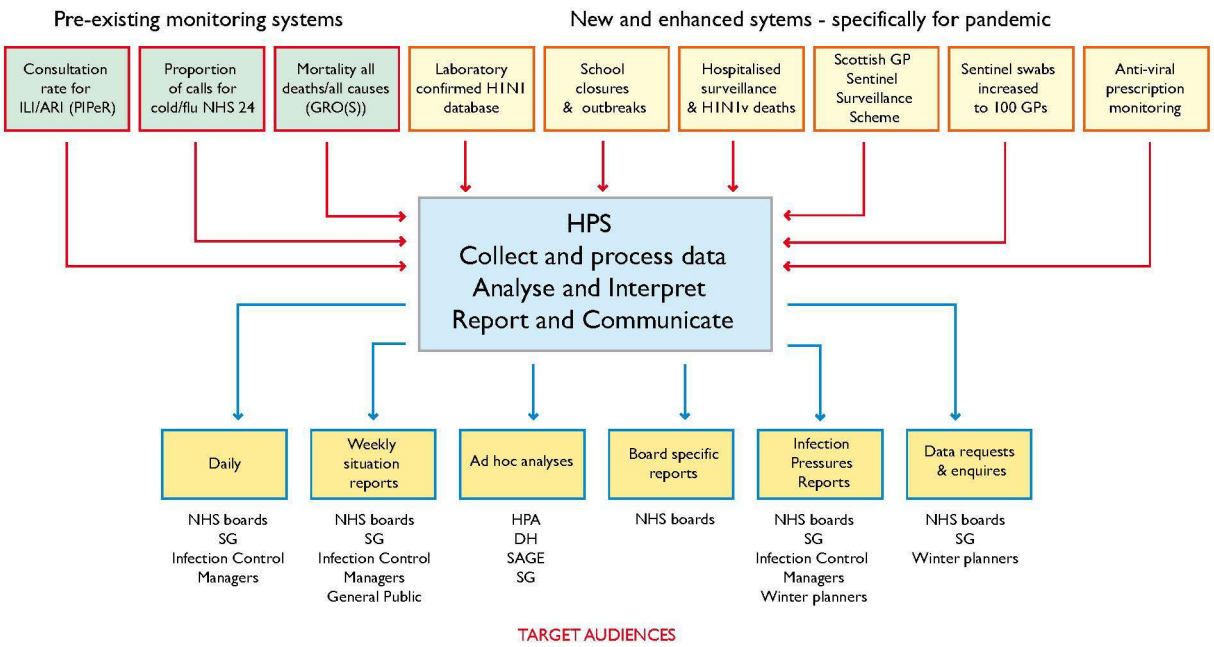
HPS Pandemic Flu Surveillance Systems operational during Containment Phase					
System	**Objective**	**Data source**	**Data set**	**Outputs**	**Reports**
Case investigation*	Detecting and investigating confirmed cases and contacts to help assess the transmissibility and virulence of the infection	NHS Board Public Health Departments/ SFREC	Individual cases: nature of illness, previous exposures to flu, travel and close contacts;	Incidence of confirmed cases; Geographical distribution	Daily: Scottish Government and NHS boards
Clusters and Outbreaks*	Detecting and defining clusters and outbreaks	NHS boards	Aggregate data on cases and contacts; school closures; antiviral use	Number and nature of clusters; School closure	Scottish Government and NHS boards
PIPeR	Measuring the extent of influenza-like illness presenting to the healthcare services	37 General practices	Individual Consultations; Anonymised demographics, reason for consultation, interventions	GP consultation rates per 100 000 population in all Scotland	Daily: Scottish Government and HPA
NHS 24 syndromes	Measuring the extent influenza-like illness presenting to the healthcare services	NH24 Call Centres	Aggregate data on calls due to symptoms. of cold/flu; fever, coughs and difficulty breathing	Proportion of all calls due to cold/ flu symptoms in all Scotland and in individual Boards	Daily: Scottish Government and NHS boards
General Practice Sentinel Swabbing for respiratory virus	Defining the proportion of influenza-like illness in the community due to Influenza A(H1N1)	105 General Practices/West of Scotland Regional virology Centre	Individual anonymised swab results from patients consulting a Sentinel GP in Scotland	Percentage of those consulting with influenza-like illness or acute respiratory infection with positive swab for Influenza A(H1N1)	Weekly: Scottish Government, NHS boards
All cause mortality	Estimating the severity of illness due to Influenza A(H1N1) infections	General Register Office Scotland (GROS)	Aggregate data on number of daily deaths in Scotland	Observed versus expected number of deaths by age, Board and date	Daily: Scottish Government and NHS boards

Table 3: Continued

HPS Pandemic Flu Surveillance: additional systems set up during Treatment Phase					
System	**Objective**	**Data source**	**Data set**	**Outputs**	**Reports**
Hospitalised confirmed cases	Estimating the severity of illness due to Influenza A(H1N1) infections	NHS Hospitals	Individual confirmed cases; demographics, clinical status; underlying conditions, hospital care and outcome	Daily numbers of new confirmed cases hospitalised	Daily: Scottish Government, HPA and NHS boards
H1N1 related Deaths	Estimating the severity of illness due to Influenza A(H1N1) infections	GROS	Individual deaths: cause of death, age, sex, residence	Total deaths by day and week	Daily: Scottish Government, HPA and NHS boards
Scottish Influenza Reporting Scheme	Measuring the extent of influenza-like illness presenting to the healthcare services	990 General practices	Aggregated data on GP consultations flu-like illness demographics, reason for consultation, interventions	Daily GP consultation rate for respiratory illness by age, Board and all Scotland	Daily: Scottish Government and NHS boards
Antiviral prescribing Rates	Measuring the extent of influenza-like illness presenting to the healthcare services	NHS e-Pharmacy	Aggregated Prescriptions for antivirals by age and NHS Board	Daily prescribing rates for antivirals	Daily: Scottish Government and NHS boards

* In operation only during Containment phase

Figure 3: Schematic of data input and reporting outputs by HPS



3.4 Epidemiological Investigations

In addition to these surveillance systems, HPS was asked to take forward three specific epidemiological investigations:

3.4.1 First Few Hundred Study (FF100)

FF100 was a UK project designed to help assess the threat from the virus and the likely success of clinical and public health interventions as soon as possible after the start of the pandemic. The dataset included; demographic and clinical data on cases and their close contacts including the results of any investigations for influenza A(H1N1).

The onset of the pandemic overtook the planned development for this programme resulting in an FF100 database being created in HPA which was not accessible by the Devolved Administrations. A variant of FF100 was therefore developed in Scotland. Individuals were contacted by calls made by either directly by HPS staff or latterly by SFREC staff trained in the follow-up of cases and their contacts. Information was obtained on 18 cases and 104 of their contacts during the first weeks of the containment phase. After this, collection of FF100 data was stopped as priority was given to the case investigation system when the infection began spreading rapidly. The Scottish data was included in an overall analysis produced by the HPA. Preliminary analysis of the information collected was essential in describing the spread of the virus (McLean et al., 2010) and informing SAGE.

3.4.2 Seroepidemiological Investigations

During the treatment phase, it became a priority to assess the likelihood and extent of further transmission and likely severity of the consequences of infection. This entailed estimating the number of people infected, how this related to the number falling ill and the number seeking care for their illness. As schools in Scotland reopen earlier after their summer vacation than in other parts of the UK, HPS received a request from SAGE to investigate the effect on spread from this phenomenon. This required a seroepidemiological investigation to establish the infection rate in a limited number of Scottish schools. Data would be used in the statistical modelling of the shape of the epidemic over the autumn/ winter. Protocols were adapted from those developed in England and mechanisms for this investigation were put in place.

The Chief Medical Officers indicated that any investigation would be conducted as a public health outbreak investigation and not as research and therefore did not require research ethics approval. HPS was alerted to a significant level of influenza-like illness in secondary schools in two boards. The presence of influenza A(H1N1) was confirmed in swabs from symptomatic pupils. However because of concerns partly about NHS board concerns about ethical approval and partly because of competing priorities in schools, the investigations did not proceed.

3.4.3 Flu Clinical Information (Flu-CIN) Project

The UK Flu Clinical Information (Flu-CIN) project was established to describe any changes in the clinical presentations of hospitalised patients and to offer early insight into the effect of interventions to inform UK management policy. In Scotland the information on the first eight hospitalised cases was used to evaluate the utility of the data collection instrument developed and allowed further refinement prior to its use across the UK. NHS Greater Glasgow and Clyde were nominated as the sentinel site for the collection of information in Scotland. NHS Quality Improvement Scotland acted in project support for the scheme. The Scottish site joined the network of sites coordinated by the University of Nottingham. The data collected were subject to regular analysis by the University. By the end of the inclusion period (1 February 2010) Scotland had provided information on 286 patients of the 1516 UK patients in the database. The output from Flu-CIN was considered by the UK Scientific Advisory Group on Emergencies (SAGE).

3.5 Key Findings

3.5.1 Confirmed Cases and Contacts: Case Investigation System (Containment Phase: 1 April to 2 July 2009)

During the containment phase 1409 confirmed cases were reported to HPS. Figure 4 presents the epidemic curve of dates of onset in confirmed cases in which the date of onset is known. The first Scottish confirmed case reported on 27 April had a date of onset of 20 April. The number of cases rose markedly on 25 May and started to fall on 11 June before rising again on the 22 June.

Figure 4: Laboratory confirmed influenza A(H1N1) cases reported to HPS during the containment phase by date of onset of symptoms (n= 662)

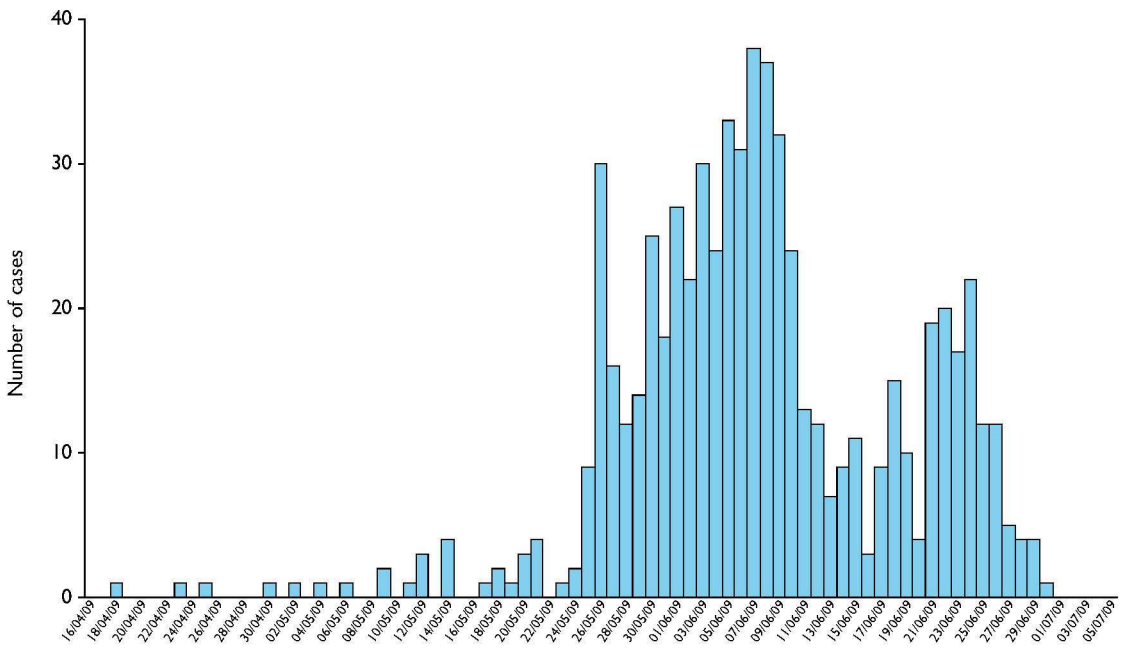


Figure 5 shows the cumulative number of laboratory confirmed cases during the containment phase. The curve flattens on 13 June indicating that for six days, there were few reports received. Most probably this was related to the introduction of the modified containment phase which led to a temporary suspension of swabbing patients in Glasgow and Clyde due to pressure on local services.

Figure 5: Cumulative laboratory confirmed cases of influenza A(H1N1) by date reported to HPS until end of containment phase (n=1409)

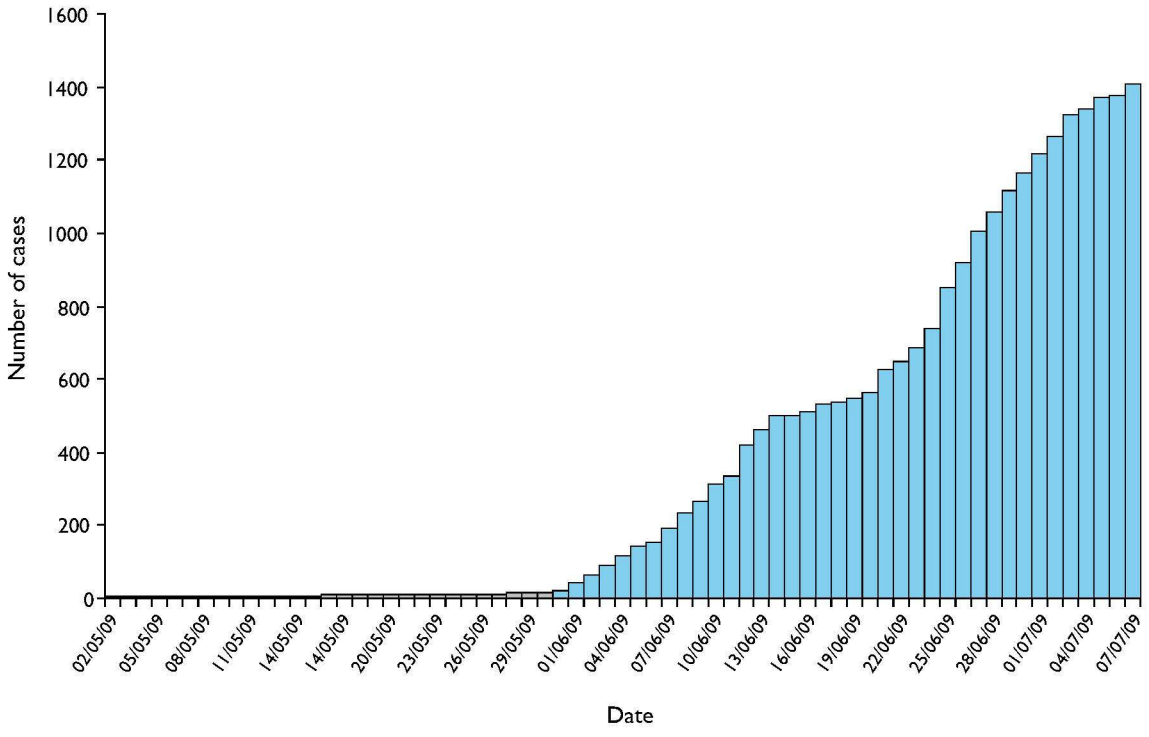


Figure 6 shows the distribution of laboratory confirmed cases by age group and gender to 2 July 2009, in whom data on these items were available. The distribution of cases between males and females were in about equal proportions. The majority of cases were within younger age groups with very few cases in the over 65 years age group.

Figure 6: Age and sex distribution of laboratory confirmed influenza A(H1N1) cases in Scotland to 2 July 2009 (n=1263)

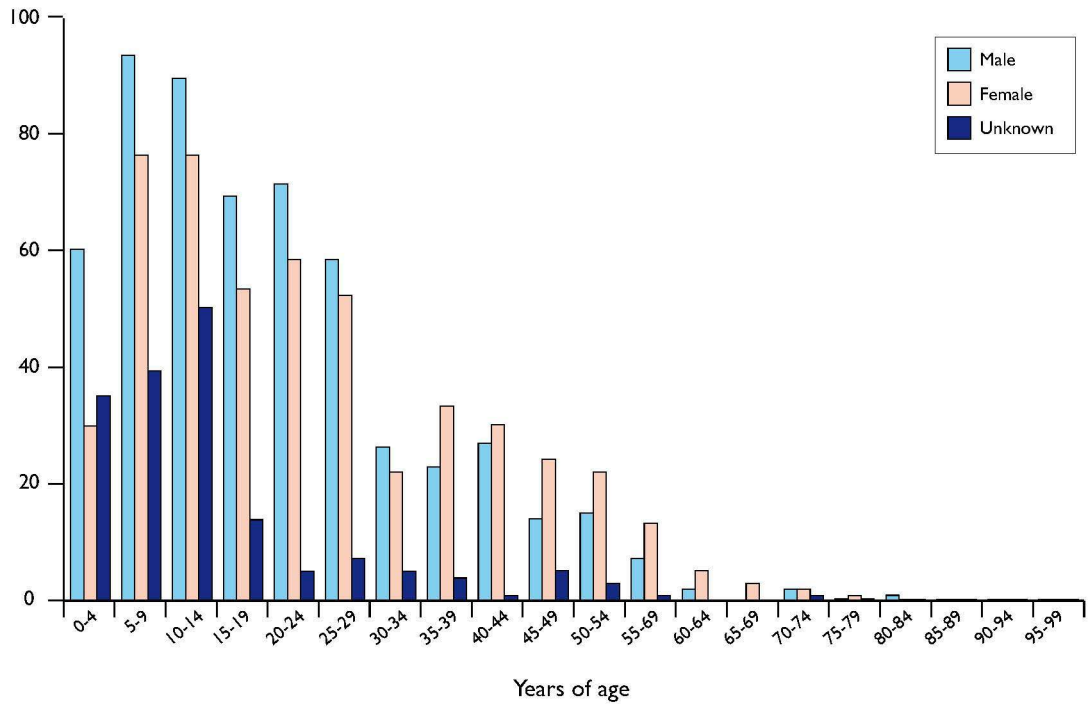


Figure 7 shows the distribution of Scottish cases by the Scottish Multiple Index of Deprivation quintile by age group. It shows cases disproportionately occurred in the two most deprived quintiles. The difference is most marked for the under 5s. The areas in which outbreaks occurred tended to be areas of relatively high deprivation.

Figure 7: Deprivation quintiles and ages of confirmed influenza A(H1N1) cases to 2 July 2009 (n=1,263)

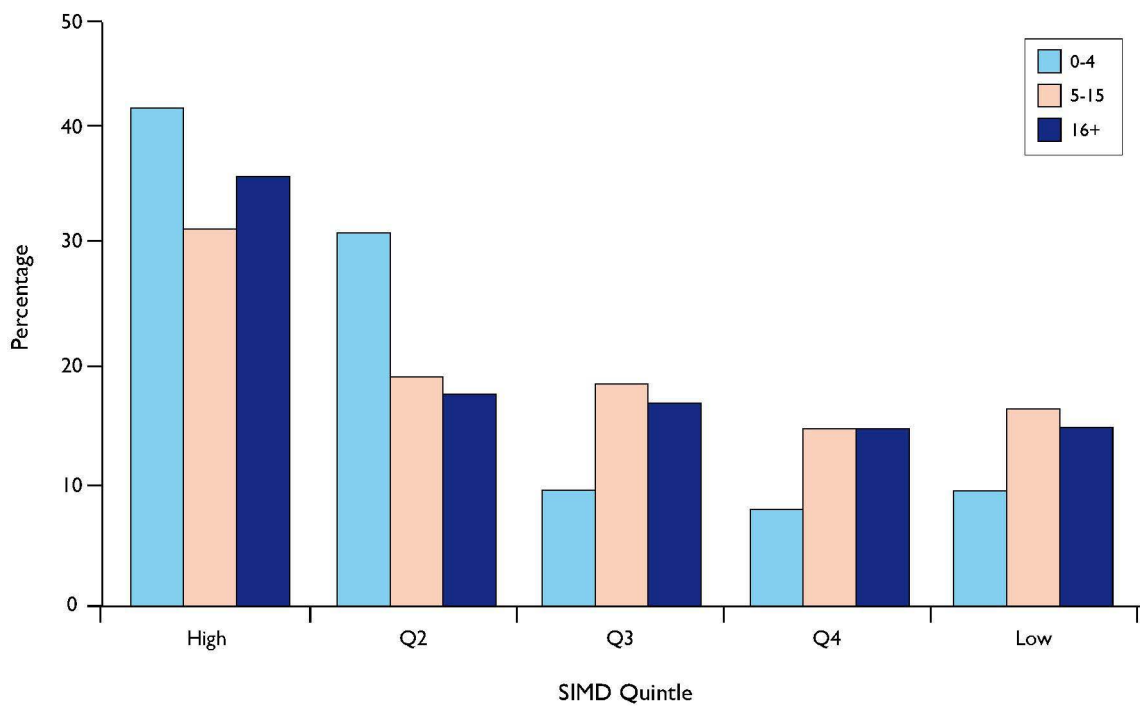
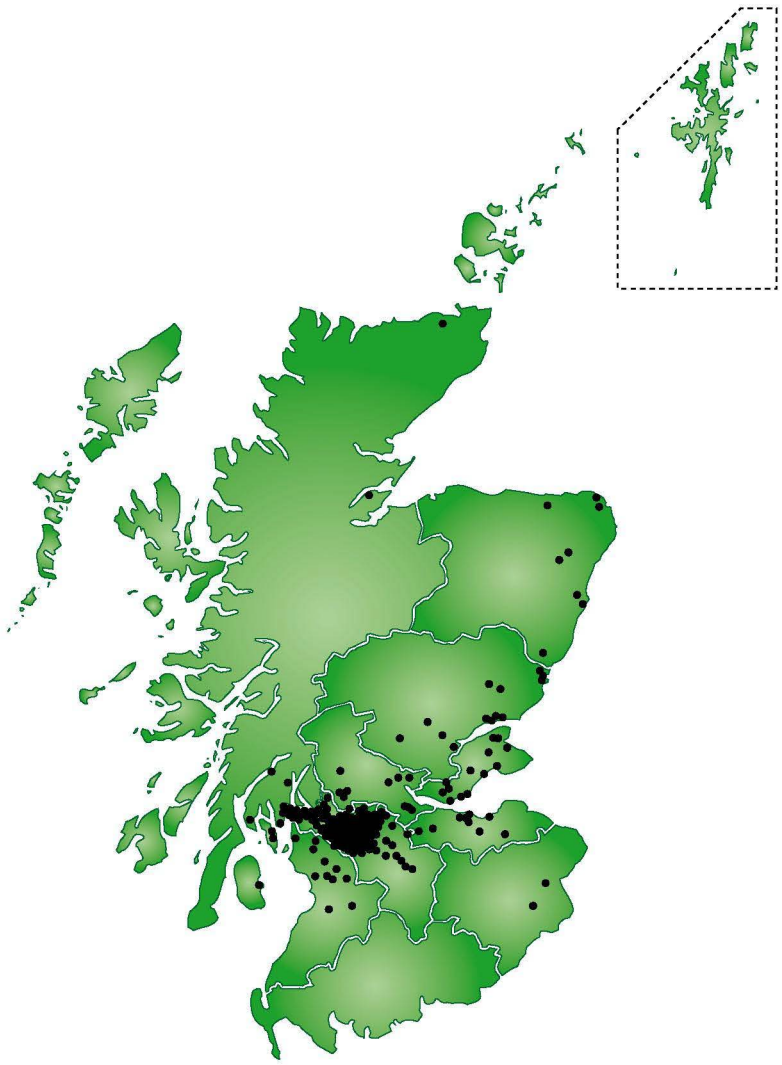


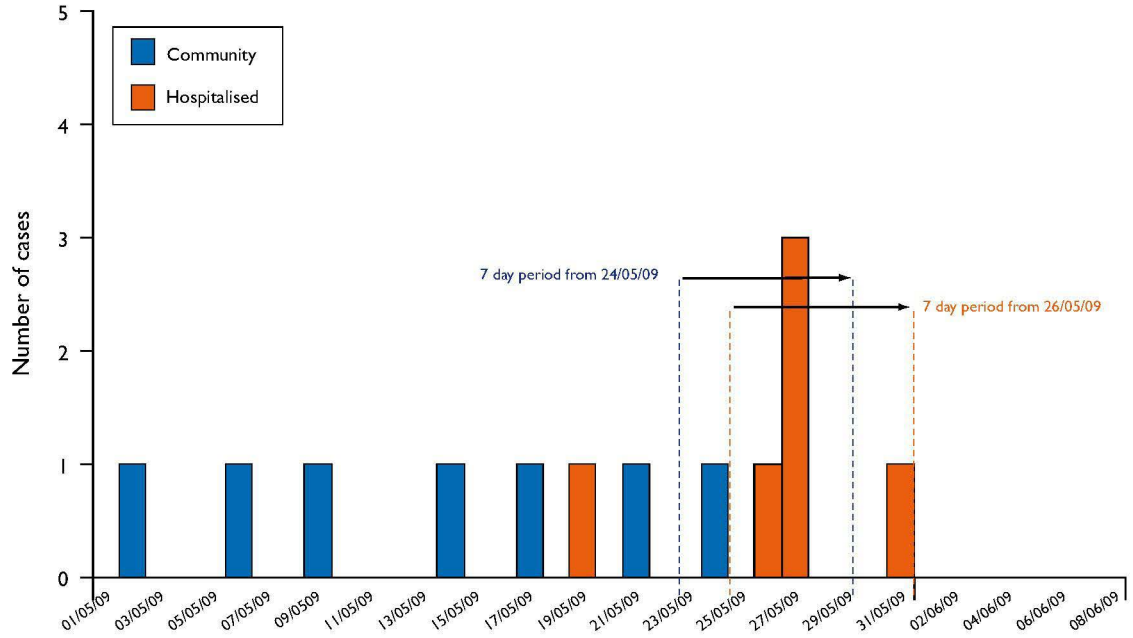
Figure 8 shows the geographical distribution of confirmed cases across Scotland during the containment phase. Cases were concentrated in the upper Clyde valley and estuary around, Glasgow, Paisley, Greenock, Dunoon and Rothesay.

Figure 8: Map of Scotland showing laboratory confirmed cases reported to HPS during the containment phase (n=1238)



During the containment phase, surveillance was vital to assess if and when sustained community transmission was occurring (defined by European Centre for Disease Prevention and Control (ECDC) as 'Five or more confirmed cases', occurring in a 'third administrative geographical area', in a seven day period, without travel history in past 7 days to a country having reported confirmed case(s) AND without traceable links to a confirmed case.' A 'third administrative geographical area' is stated to correspond approximately to a population of 500,000). In the Scotland during the period from 24 May until 9 June 2009, two overlapping time periods were identified with five sporadic cases (i.e. without links to detected cases or their contacts) within a seven day period (24-30 May five cases and 26-31 May five cases). These are shown in Figure 9.

Figure 9: Sporadic laboratory confirmed influenza A(H1N1) cases reported to HPS by date of onset (n=13) 8 June 2009



Data collected via the case investigation forms on cases and their contacts, were used for a number of statistical modelling purposes including an estimate of the reproductive number (R_0) : the average number of new cases in the population resulting from transmission from a confirmed case. If the value of R_0 is above 1.0 it indicates that there is sustained transmission within the population. By the end of May, the estimated values in Scotland were higher than 1.0 by the two methods used for estimation, 1.53 (95% CI 0.98-2.78) by the Farrington method (Farrington et al., 2003) and 2.34 (95% CI 1.87 – 2.80) by the Wallinga method (Wallinga and Teunis, 2004). At this time, these values were higher than overall estimates for the UK.

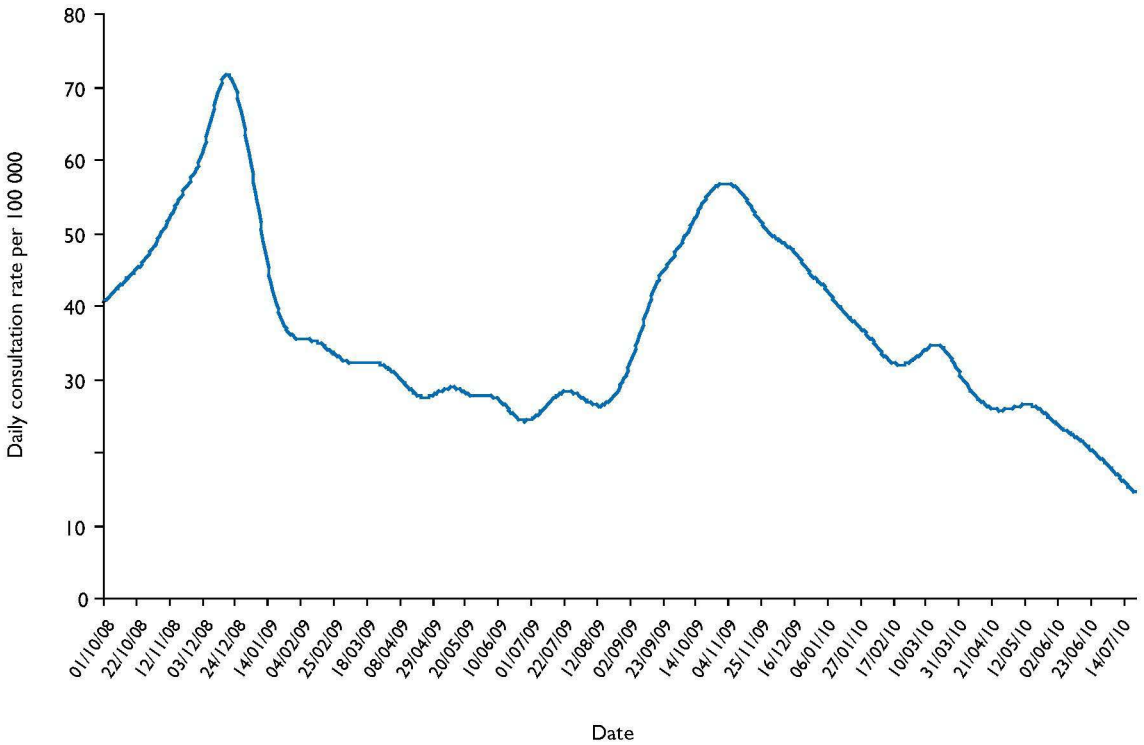
3.5.2 Clusters and Outbreaks of Influenza A(H1N1) Infection (Containment Phase: 1 April to 2 July 2009)

During the containment phase, 5 clusters of confirmed cases were detected: Forth Valley (3 confirmed cases), Greenock (6 confirmed cases), Govanhill (Glasgow) (9 confirmed cases), Dunoon (131 confirmed cases) and in the Royal Alexandria Hospital. The cluster in the Royal Alexandria Hospital, Paisley demonstrated secondary, tertiary and quaternary transmission within a hospital environment.

3.5.3 The Extent of Influenza-like Illness Presenting to the General Practitioners: (April 2009 to July 2010)

Figure 10 shows the daily GP consultation rate for influenza-like illness and acute respiratory infection in Scotland for 2008 and 2009 as measured by PIPeR.

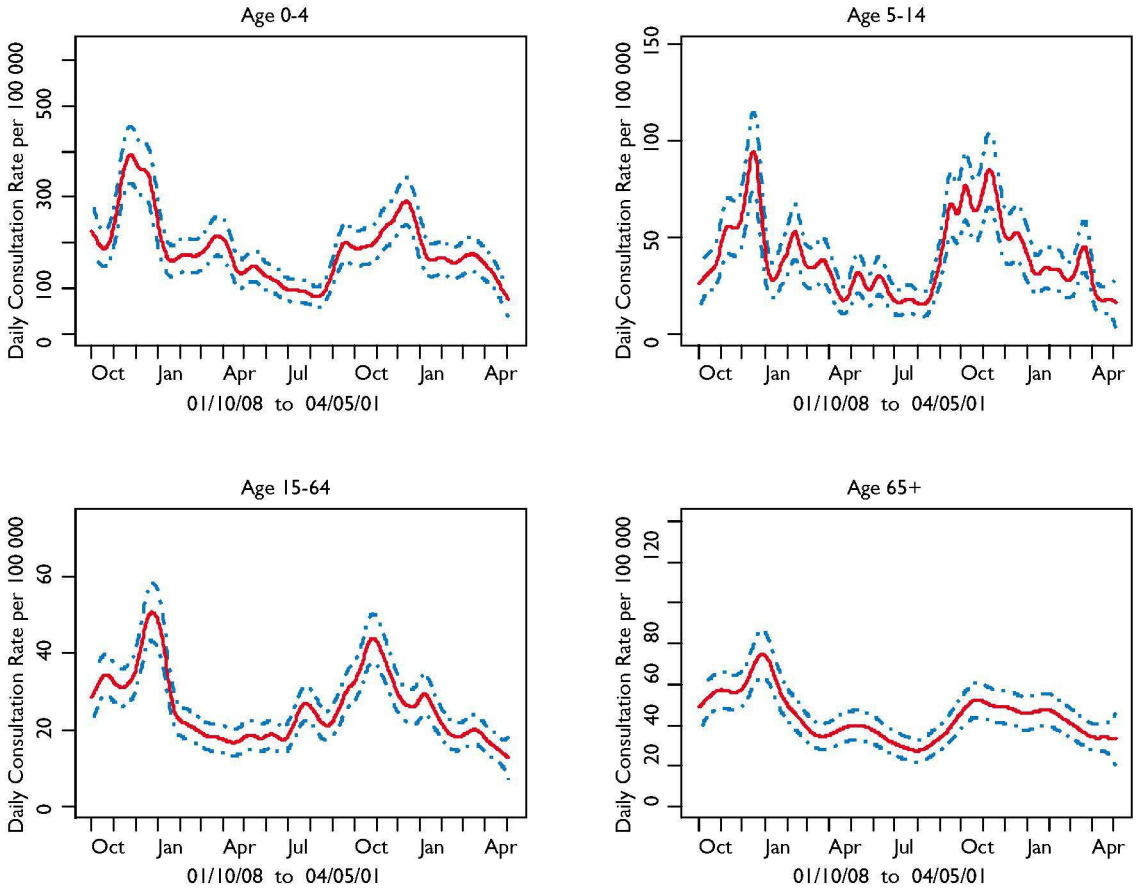
Figure 10: Daily GP consultation rate for ILI and ARI until 14 July 2010 all Scotland, all ages



There was no decrease in June 2009 and a small increase in August 2009 in contrast to the decrease seen in consultation rates from May 2010 which is the pattern observed routinely in a normal year. Rates started to increase in September to late November 2009 when activity peaked gradually falling to the end of February 2010. The peak of consultation rates in 2009 was therefore earlier and lower than that for 2008. The duration of the increase in clinical consultations and laboratory reports was for a longer duration than in 2008/09.

The trends in consultation rates by age groups are shown in Figure 11. In comparison to the other age groups, the over 65 years age group have a much less defined peak. The rates remained highest in the 0-4 years age group throughout the period of monitoring.

Figure 11: Consultation rates for ILI and ARI by age group until 31 March 2010



3.5.4 Scottish Influenza Surveillance Reporting Scheme

The individual NHS boards' tends in consultations largely followed the all Scotland trend over the surveillance period. The peak GP consultation rate for all the NHS boards are shown in the Table 4 which shows that all the boards reported peak in GP consultations between 11 November and 8 December 2009. Consultation rates peaked earlier in southern boards.

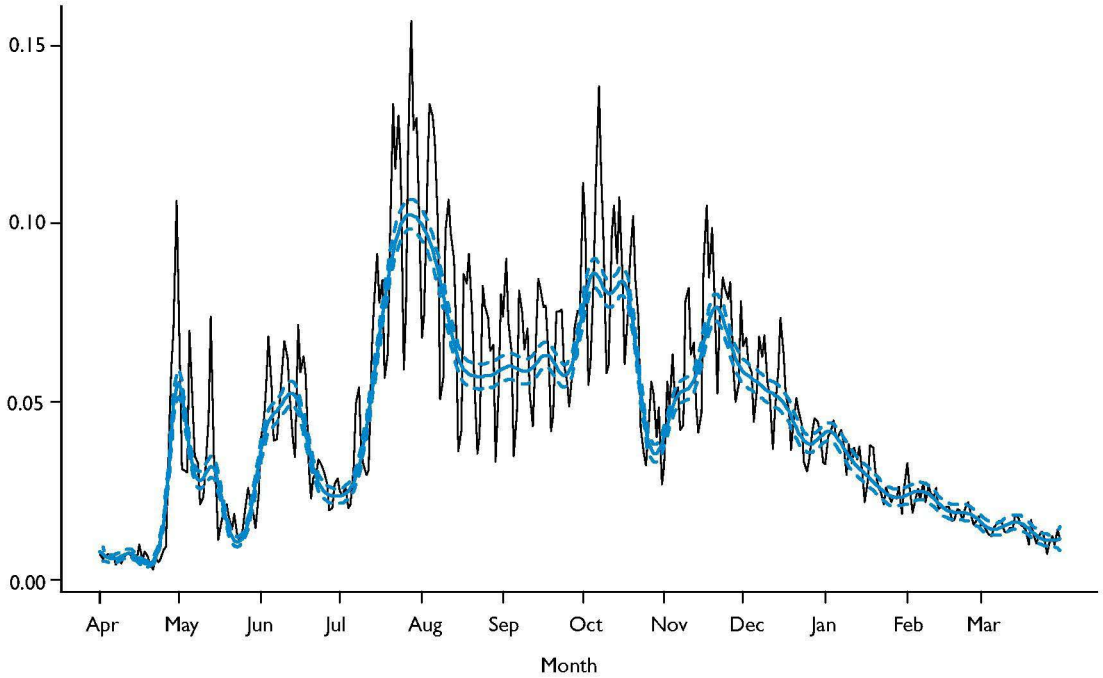
Table 4: Peak week of GP consultation rate for influenza-like illness by NHS board (SISRS)

Peak week (date commencing) in 2009	NHS board	GP consultation rate per 100,000 population for that week
11 November	Borders	153.2
	Greater Glasgow & Clyde	149.6
	Lanarkshire	156.5
18 November	Fife	104.5
	Forth Valley	100.6
	Dumfries and Galloway	120.4
	Tayside	158.5
25 November	Lothian	91.7
	Ayrshire and Arran	142.4
	Highland	183.0
	Grampian	97.9
	Orkney	90.8
2 December	Shetland	80.8
	Western Isles	146.9
25 November	Scotland	119.9

3.5.5 NHS 24 Syndromes Surveillance

Figure 12 shows the proportion of calls to NHS 24 for cold/flu like symptoms for April 2009 to March 2010. Unlike the trend from PIPeR, there was an increase in proportion of calls during early May 2009. The age groups 5-14 and 15-64 accounted for the highest proportions and numbers of cold/flu calls.

Figure 12: Proportion of cold/flu calls to NHS 24 across Scotland from April 2009 to 30 March 2010

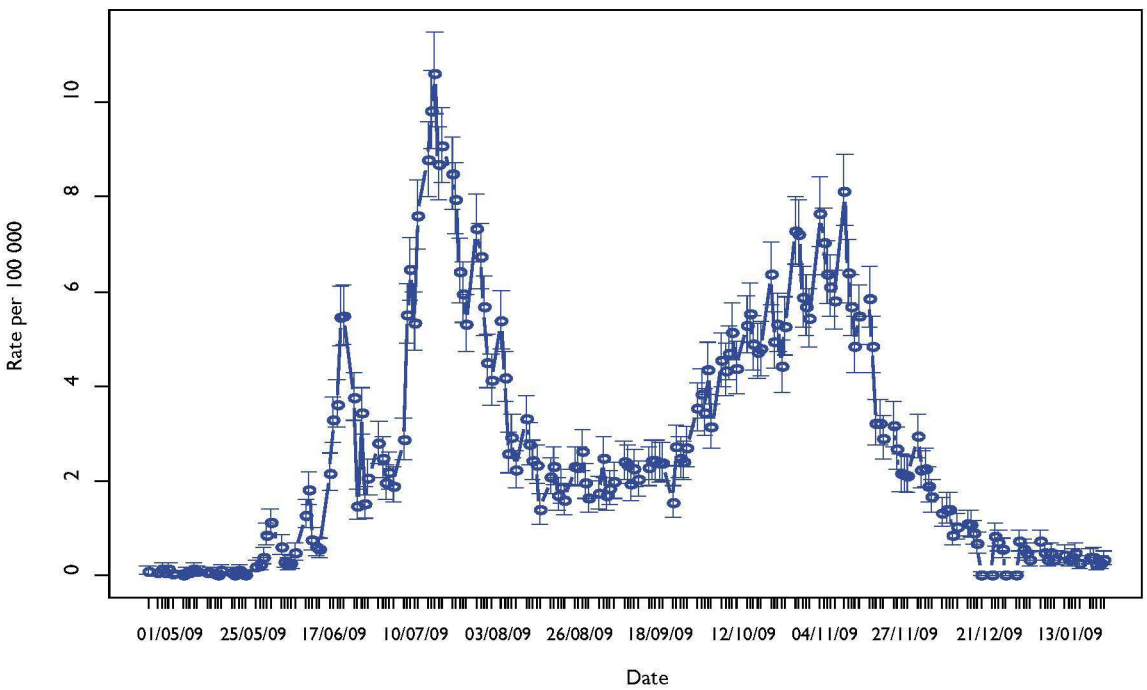


Note: The blue line represents the smoothed trend and the dotted blue line is the confidence interval which represents the expected variability.

3.5.6 Antiviral Prescribing Rates from 1 April 2009 to 31 March 2010

Antiviral prescribing patterns were broadly consistent with the increasing trends seen in General Practice consultations and hospital admissions. The rate of antiviral prescribing corresponded to the peak of all Scotland GP consultation rate showing a peak in prescribing occurred in the mid to late November.

Figure 13: Antiviral prescriptions (oseltamivir and zanamivir) for all Scotland from end April to 25 January



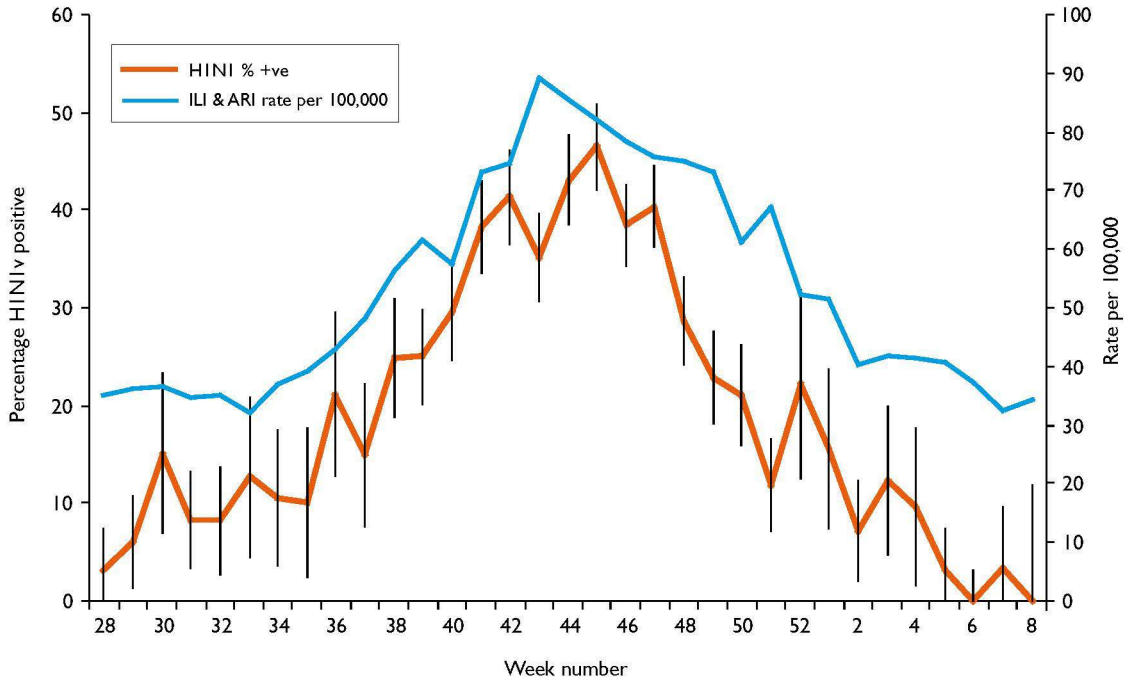
These data show there were three peaks in the rate of antiviral prescribing across Scotland which occurred in:

- End June 2009 which corresponds to offer of treatment and prophylaxis to all cases and contacts within the containment phase.
- End July which is thought to relate to the widespread offer of antivirals at treatment centres established at this time.
- End November which correlates well with the picture seen across the community and hospital settings.

3.5.7 The Proportion of Influenza-like illness in the Community Due to Influenza A(H1N1): Sentinel Swabbing for Respiratory Viruses

Figure 14 shows the swab positivity rate (% of GP consultations for influenza-like illness and acute respiratory infections) for influenza A(H1N1) alongside the GP consultation rate for ILI and ARI over the time period from week 28 until week 8.

Figure 14: Influenza A(H1N1) percentage of all swabs positive in those consulting ARI and ILI in sentiel general practices and overall all Scotland and GP consultation rates for influenza-like illness and acute respiratory infection



*Appendix 1 gives the date for each report week.

The trend in the swab positivity rate generally mirrors that of the consultation rate with maximum swab positivity rate peaking at 51% in each day.

3.5.8 The Severity of Illness Due to Influenza A(H1N1) Infections: All Cause Daily Mortality

All Cause Mortality

This figure shows the expected versus the observed deaths by all causes to 13 March 2010.

Figure 15: Expected versus observed deaths by all causes to 31 March 2010

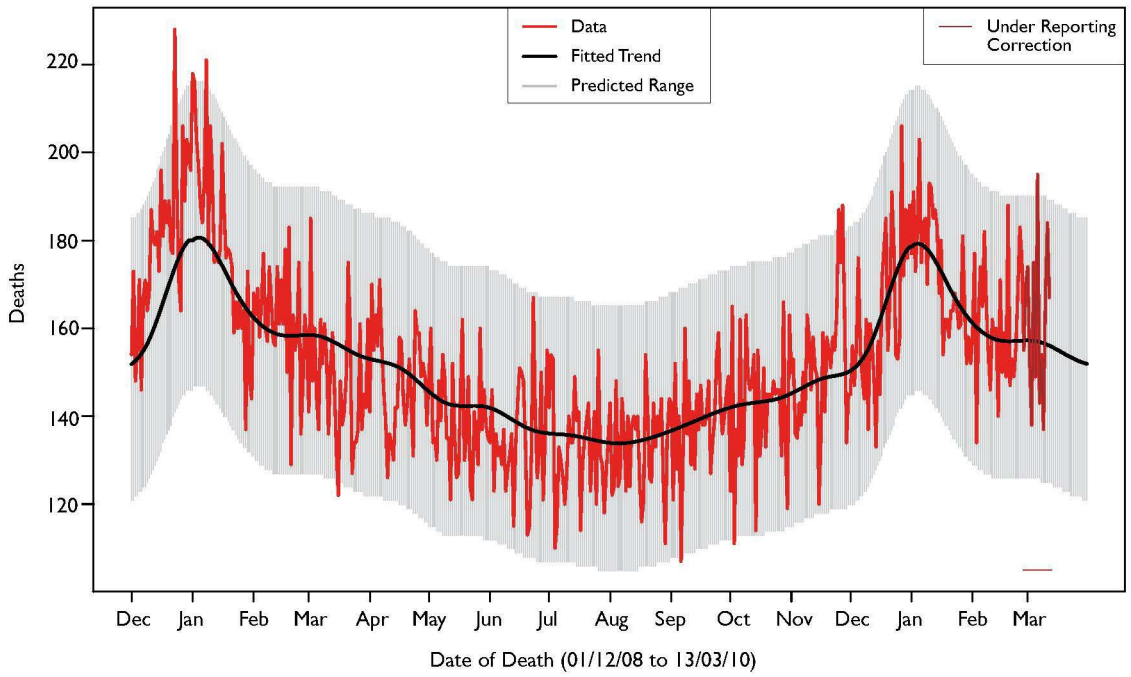


Figure 15 shows that over the period of the pandemic year, there was a peak in deaths by all causes in December and January 2009/2010 which is consistent with historical trend data. However there was also a slight excess of deaths over the expected number in late November; at the same time of the peak in GP consultations, antiviral prescribing and NHS 24 calls. The increase noted at the end of November was closely monitored to determine if this was evidence of an early start to the usual observed peak of deaths by all causes. However this exceedance did not form part of sustained increase. Over the subsequent weeks, the number of deaths remained within the predicted range for the time of year.

Cause Specific Mortality

There were 69 deaths reported to HPS in which influenza A(H1N1) had been stated on the death certificate. The overall death rate in hospitalised cases was low (4.3%), with the majority of deaths occurring in adults aged 16 years and over (76%). Around 1% of children who were admitted died compared to 5.8% of adults aged 16 years and over. The median age of death in adults was 52 years of age (range 16-85 years).

Table 5: Deaths in patients infected with Influenza A(H1N1) by age group and gender

Age Group	Female	Male	Total
0-9	1	3	4
10-19	4	1	5
20-29	3	5	8
30-39	5		5
40-49	5	4	9
50-59	10	6	16
60-69	4	7	11
70-79	2	6	8
80-89	3	0	3
Total	**37**	**32**	**69**

The overall proportion of laboratory confirmed clinical cases who died (case fatality rate) was 0.07%.

The main presenting symptoms in fatalities were ILI and upper respiratory tract infection (URTI). A higher proportion of children presented with a mixture of respiratory and gastro intestinal symptoms than was found in adults. Of the 69 cases at least 70% (48/69) were known to have underlying medical conditions including: diabetes (6), a respiratory condition (15), obesity (10), renal/liver conditions (12), congenital abnormalities (9), immunosuppression (8), pregnancy (3) and a malignant illness (6). In some cases, there were multiple conditions present. The majority of deaths occurred in NHS Greater Glasgow & Clyde.

3.5.9 The Severity of Illness Due to Influenza A(H1N1) Infection: Hospitalised Confirmed Cases

A total of 1542 individuals with confirmed influenza A(H1N1) infection were admitted to hospital during the Pandemic. Figure 16 shows the number of new cases each week over the period of monitoring. Hospitalisations then increased rapidly from the beginning of October more than doubling each week before initially peaking towards the end of October. Numbers of new cases remained at similar but slightly reduced levels over the next five weeks rising to a second peak in mid-November.

Figure 16: Cumulative number of hospitalised to 31 March 2010

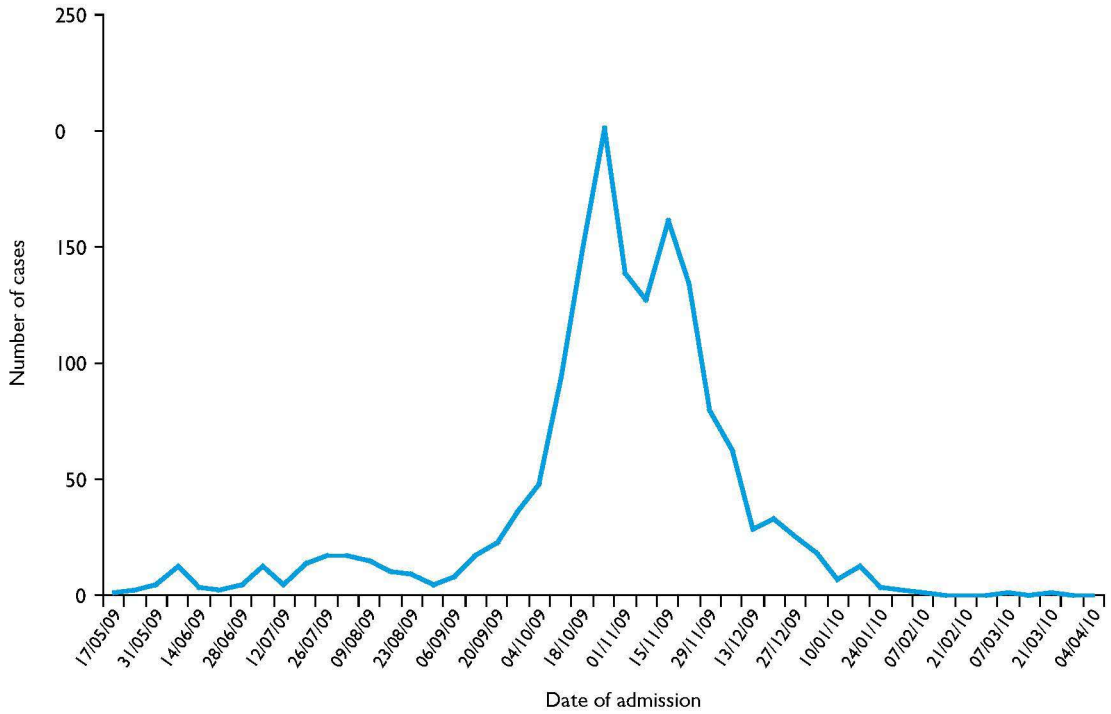
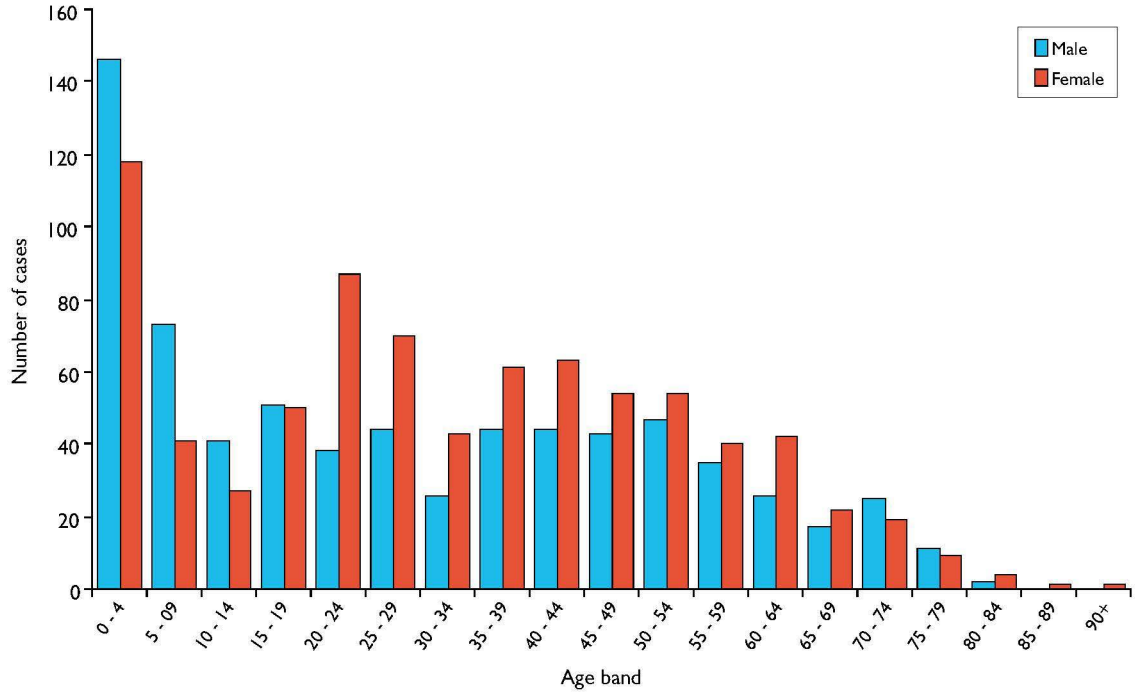


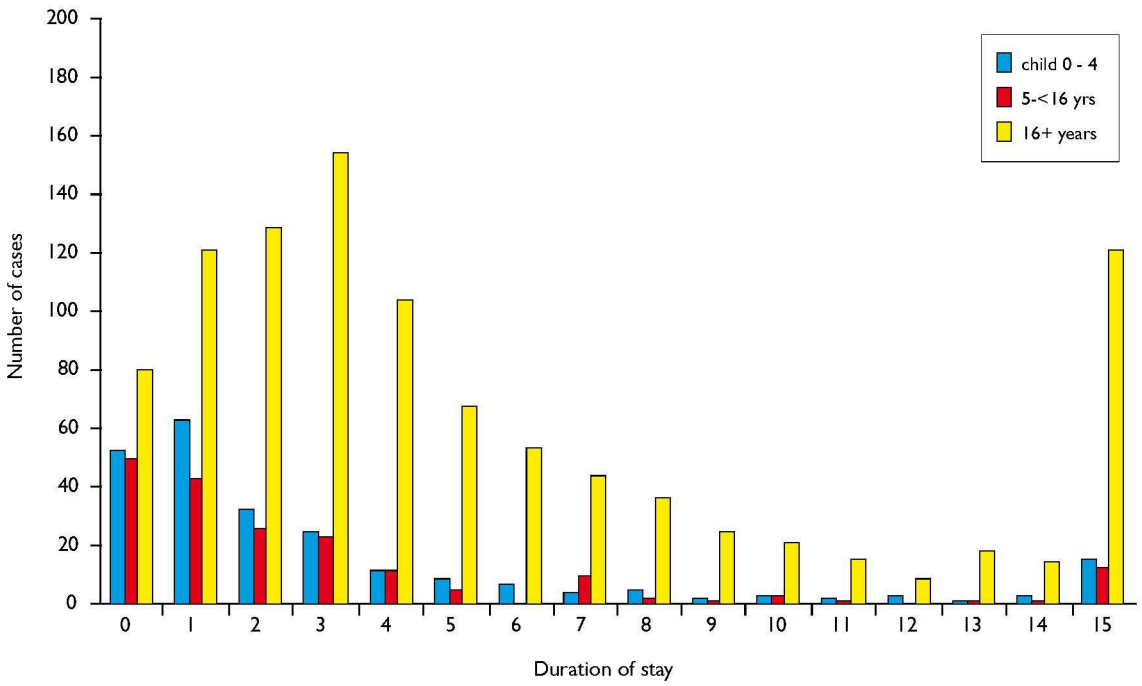
Figure 17 shows the hospitalised cases by age group and gender (known for all cases). Gender distribution of these cases was fairly even between males and females (47% versus 53%). The majority of cases were in adults aged 16 years and over (69% (1050/1516)) with around a third in children under 16 years of age (30% (469/1516)). Of those aged under 16 years of age, over half were in the under 5 year age group (57% (264/469)).

Figure 17: Hospitalised cases by age group and gender (known for all cases)



A breakdown of the number of cases by age group and length of stay in hospital is shown in Figure 18. The majority of cases (90%), for which both the date of admission and date of discharge were available were in hospital for less than 14 days.

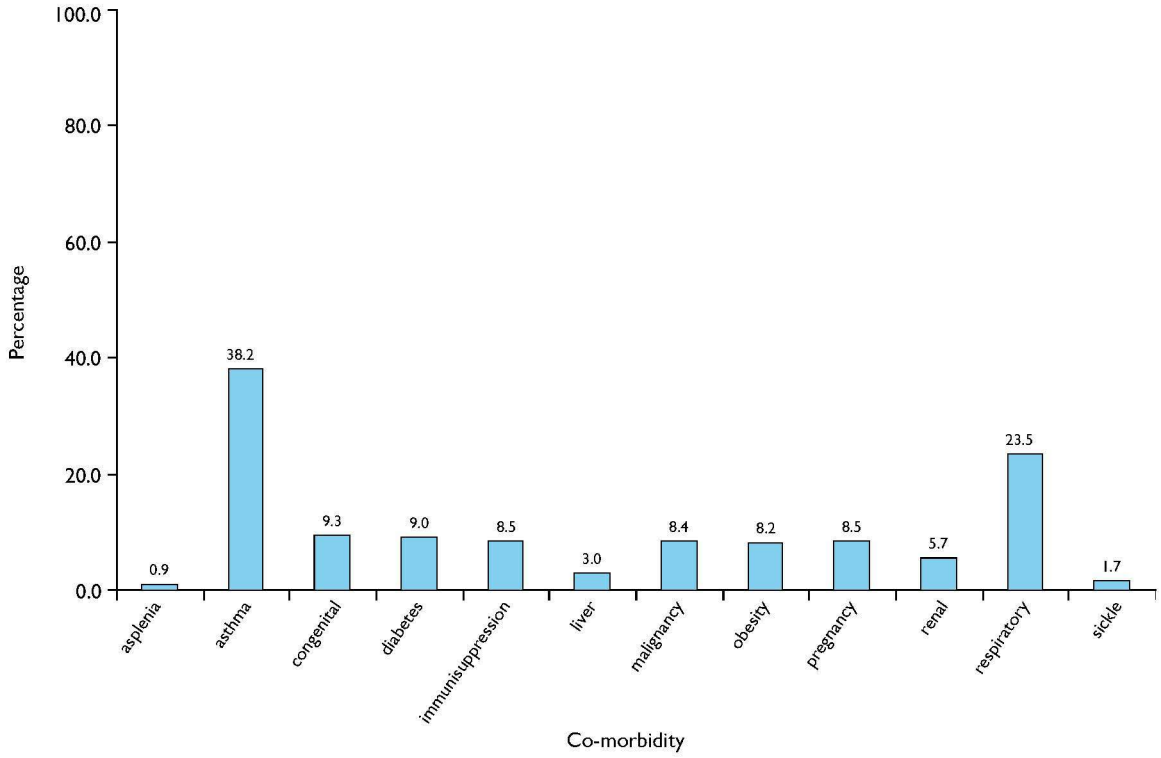
Figure 18: Number of cases by age group and length of stay in hospital



Significantly more children under 5 years of age did not have a co-morbidity specified (82%; 217/264) compared to other age groups. The majority of children aged between 5 and 16 years (60% (81/205)) had a co-morbidity specified. Around half of the adults aged 16 years and over had at least one co-morbidity specified 52% (505/1050).

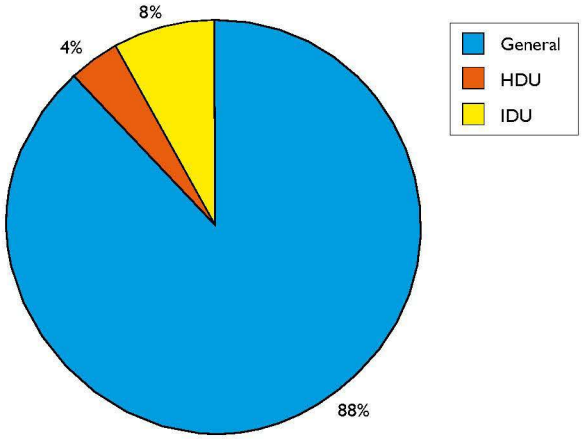
Figure 19 shows percentage of specified co-morbidities broken down by condition. Asthma was the most common co-morbidity stated (38% of cases) (242/633). The second most common was respiratory disease (24%, 149/633). A small proportion of cases (52/633; 8%) had obesity listed (1.5%). A total of 54 women (54/633; 8.5%) had pregnancy listed at the time of their illness.

Figure 19: Percentage of co-morbidities by specified condition



The pie chart below shows a breakdown (percentage of total cases) of the maximum level of care received by all cases admitted to hospital. Eight percent of cases (129/1519) required the highest level of care (ITU) at some point during their stay. The majority of patients (88%; 1332/1519) were only ever in general wards and did not require a higher level of care.

Figure 20: Maximum level of care received by hospitalised patients



The majority of cases (83%) did not receive antiviral treatment prior to admission to hospital; 257 cases (17%) received antivirals prior to hospitalisation. A large proportion of cases (60.8%) who received antivirals prior to admission had a co-morbidity specified.

3.6 Lessons Learned

The following are the key issues fed back from the three debriefings:

What worked well

- Local investigation of clusters.
- Contribution of SFREC.
- Implementation of new surveillance system with increased coverage of all areas of Scotland.
- Development of improved IT interfaces to support reporting.

What should be improved

- Planning mass testing and treatment facilities e.g. access to swabbing.
- The management of data associated with surveillance and epidemiological investigation systems.
- Definition of the ethical framework for outbreak investigation.

3.7 Discussion

3.7.1 Limitations

The necessity for the substantial increase in surveillance activity and the short turn around time for reporting caused a huge increase in the amount of data managed by HPS. Systems were required to be developed or modified very quickly with limited time for testing and investigation and this resulted in them being established at the same time as they were required to report. Statistical modelling had to be employed to correct for differences in data due to these amendments so as to produce trends.

During the containment phase of the pandemic, the main focus was on the collection of detailed epidemiological and clinical data to inform the modelling. The FF100 surveillance system had been originally developed before the onset of the pandemic as a notional extension of the avian influenza database surveillance system. However at the start of the pandemic, it quickly became evident that the FF100 study was unlikely to be able to meet the local information and management needs during the pandemic. In hindsight, the FF100 required large efforts from NHS boards and from HPS to collect and collate the data. It was able to provide information which was useful for modelling to predict the course of the pandemic, but it did not produce outputs from the epidemiological analyses which met Scottish needs.

The detection and management of cases in the containment phase was set out in a series of algorithms which became more complex as the pandemic evolved. Surveillance was reliant on the completion and submission of case investigation forms by the health protection teams. These also underwent modifications and this presented challenges for NHS boards. As the numbers of cases started to rise substantially, this caused a considerable burden on a number of staff involved in this aspect of the response. Organising swabbing and testing became very burdensome. Within NHS Greater Glasgow & Clyde, the evolving situation became untenable because of the pressure on primary care services and surveillance had to be temporarily suspended.

The was an intense focus on the sereverly unwell in the early stages of the pandemic. However, it was not possible to provide the public with an accurate population risk. Partly this was due to inevitable delay in there being a serological test to help estimate the proportion of the population infected with the virus. Without this the calculation of what proportion of those infected fell seriously ill was not possible.

There were no seroepidemiological studies undertaken during the pandemic and although initial serum samples were collected as part of the FF100 investigation, a serology test for influenza A(H1N1) antibodies was not available at that time. A seroepidemiological study of children in Scotland has now been completed and has yielded valuable findings and enabled estimation of the proportion of children that have protective antibody levels and to estimate existing susceptibility in this population.

There were continual requests for comparison of the pandemic with seasonal influenza. However there were a number of factors which made this difficult. This included lack of historical data during the summer months as monitoring normally takes place during the influenza season (October to April) and an absence of prior daily baselines for many of the new systems implemented, particularly for hospitalised cases.

3.7.2 The Epidemiology of the Pandemic in Scotland

Consultation rates for influenza-like illness reached their highest levels in mid-November 2009, the peak being earlier and lower than that seen in the previous year for seasonal flu. Mid to late to November 2009 also saw: a peak in the number of calls to NHS 24 reporting symptoms of colds and influenza; a peak in swab positivity and the peak in hospital admissions of patients with severe influenza A(H1N1) infection. In addition there was evidence of small excess in deaths by all causes at this time. The duration of the increase in clinical consultations and laboratory reports was for a longer duration than in 2008/09. Analysis of laboratory data from both the sentinel systems and from samples submitted for clinical reasons, showed that unlike previous seasons, influenza A(H1N1) was the only predominate strain during the period September 2009 to March 2010, a situation which was unique.

In the containment phase, confirmed cases were more frequent in 5-14 year olds followed by 15-24 year olds. In the treatment phase, consultation rates for influenza-like illness were highest in the 0-5 year olds followed by the 5-14 year olds. This picture contrasts with the usual picture seen in seasonal influenza in that in the pandemic, persons 65 years and

older were least affected. This pattern has been consistently observed across the UK and beyond (HPA, 2009, Ikonen et al., 2010, McLean et al., 2010). It has been postulated that this distribution of age pattern was due to possible previous exposure to other strains of influenza A(H1N1) within the older age groups (Ikonen et al., 2010).

Transmission in children is acknowledged as the main driver of wider community spread of influenza. There was a reduction in GP consultation rates around the time of the Scottish summer school recess at the end of June. This continued until the return of the Scottish schools at the end of the third week in August. After this rates began to rise again. Fortunately the timing of the first pandemic wave had only modest impact on the examination timetable.

During the containment phase, the infection was mainly limited to the area around the Clyde Estuary. There is clear evidence that sustained community transmission was happening in the Clydeside conurbation and Clyde estuary in the last weeks of May. Epidemiological investigation showed that in four of the clusters, the index cases were sporadic. The effectiveness of limiting the rate of transmission from sporadic cases depends on the promptness of their detection and subsequent intervention. The evidence acquired from investigation of the Dunoon cluster indicated that once a 'critical' mass of people were infected, e.g. such as occurred on the football supporters' bus, it is likely that secondary transmission has been too extensive and rapid for interventions to be totally effective.

It is unclear why the west of Scotland bore the brunt of infections during the containment phase. However during the treatment phase the pattern was reversed with the east and the North of Scotland displaying higher peak rates of infection in primary care, and by the end of the pandemic higher rates of hospitalisation. The results of serological studies have shown that higher proportion of the population in the east and north have had exposure to the pandemic strain of the virus (Adamson et al., 2010).

During the containment phase, the incidence of clinical cases appeared to have a strong association with higher levels of socio-economic deprivation. This finding and the appearance of a similar simultaneous pattern in the West Midlands is the subject of ongoing scrutiny.

Unlike the situation in Northern Ireland there was only one outbreak of pandemic influenza in a childhood special needs (neurodisability) setting. There was however a number of schools particularly in the Cowal peninsula, Greater Glasgow, Forth Valley and Lothian areas in the containment phase that had significant school absence resulting in escalation of public health response to manage the risk by recommending school closure to the local NHS board health protection team.

Across the pandemic HPS are aware of only one significant outbreak in an acute hospital setting. This occurred during the containment phase in unusual circumstance in which a patient whose main presenting symptoms were gastro-intestinal in nature infected healthcare workers and patients alike. All such infected individuals made a full recovery and the episode served as a timely reminder of the critical importance of the requirement to adhere to infection control practices to ensure that such incidents were exceptional.

In general during the treatment phase, the pattern of illness observed was similar in the different surveillance systems except for NHS 24. The proportion of calls for cold/flu had their peak in early August, weeks before the return of the schools from summer vacation at a time when GP clinical reporting and swab positivity rates were relatively low. This may reflect the media reporting of the pandemic particularly the launch of the National Pandemic Flu Service (NPFS) in England. Further evidence to support this premise is provided from analysis of other NHS 24 syndromic data consistent with influenza (e.g. calls in which fever are reported) which indicate that such call proportions did not increase until swab positivity rates had also begun to increase in September.

A high proportion of patients admitted to hospital were known to have underlying diseases, including chronic respiratory disease, diabetes or immunosuppression. Seventy percent of the 69 influenza A(H1N1) related deaths, were also recorded as having underlying medical conditions, with respiratory conditions the most common.

The range of risk factors associated with increased risk of complication during the pandemic in Scotland and the rest of the UK were similar to that recognised in those under the age of 65 who are vaccinated for seasonal influenza. There were however a few important distinctions. The first was that pregnant women, as noted in previous pandemics, appeared to be at higher risk of complication. A second recognised in Northern Ireland but less so in Scotland and the rest of the UK was the burden borne by those children with chronic neurological problems. These differences led to specific targeting of these at risk groups once the pandemic vaccine became available.

The proportion of hospitalised cases recorded as having a recognised risk factor varied markedly by age. The great majority of children did not fall into a recognised clinical at-risk group This analysis supported the earlier evidence provided to JCVI from the UK Flu-CIN project and gave justification to the extension of the pandemic influenza vaccination campaign to target all children under the age of 5. Further analysis across the UK is planned to consider the implication of the findings that in excess of half of all patients recorded with asthma were not on inhaled or oral steroids and thus were ineligible for seasonal or pandemic influenza vaccination.

The overall case fatality rate in Scotland was higher than that observed in England: 0.07% compared to 0.04% (Donaldson 2009). This finding is deserving of further detailed analysis. Such planned analysis which will be undertaken jointly with colleagues in the HPA and in the Devolved Administrations. This will make adjustment for differences in age, sex, socioeconomic factors, underlying levels of pre-existing medical conditions, antiviral treatment and any differential rates of pre-existing immunisation against seasonal and pandemic influenza.

3.8 Conclusions

HPS's objectives for surveillance and investigation during the containment phase were:

- Detecting and investigating confirmed cases and contacts to help assess the transmissibility and virulence of the infection.
- Detecting and defining clusters and outbreaks.
- Measuring the extent of illness presenting as influenza-like illness to the healthcare services and its distribution within the population.
- Reporting on the above to stakeholders.

In the initial stages, the planned systems were not fully fit for these purposes. There was no Scotland-wide field epidemiology tool which could be used for investigating cases. In the later stages of the containment phase, surveillance in certain parts of the country had to be suspended due to the pressure put on primary care services by the large number of people presenting to them. Overall though, the surveillance activities during the containment phase, which were undertaken by NHS boards and HPS, were largely successful in that they enabled detection and confirmation of cases and supported follow up of their contacts. Data describing their characteristics was made available for modelling to predict the impact of the pandemic. The spread of the infection throughout Scotland was monitored and reported on.

In the treatment phase, the objectives were:

- Measuring the extent of illness presenting as influenza-like illness to the healthcare services and its distribution within the population.
- Defining the proportion of influenza-like illness in the community due to influenza A(H1N1).
- Estimating the severity of illness due to influenza A(H1N1) infections.
- Identifying changes to the virus particularly with respect to its transmissibility and its susceptibility to antiviral drugs.
- Reporting on the above to stakeholders.

A number of the surveillance systems had to be developed and established at the same time as data collection, processing and reporting was ongoing, causing problems in the interpretation of findings. There were opportunity costs to this particularly for hospitals' infection control staff who had deferred a number of activities to collect data on the severely ill. Achieving these entailed HPS working closely with primary care, hospital, laboratory, health protection and Government services. On the whole, the objectives were achieved.

3.9 Recommendations

Management of the Seasonal Influenza Immunisation Programme

- HPS should seek to harmonise Scottish seasonal flu surveillance systems with those in other parts of the UK and ensure a common approach to coding those aged under 65 years who are in groups at increased risk of infection and need to be called fro immunisation.
- HPS should review the future shape of seasonal flu surveillance systems taking into account the lessons learned in the pandemic.
- HPS should better assess the burden of disease due to seasonal influenza (including the impact on ITUs and HDUs) and the effectiveness of interventions.
- HPS should review the costs and benefits of the surveillance of severe acute respiratory infections in hospital settings, in conjunction with other UK health protection organisations.
- HPS should collaborate with UK colleagues in examining factors (e.g. socioeconomic) which may explain the apparently higher case fatality rate in Scotland.

The Development of Health Protection Services in Scotland

- HPS should review the costs and benefits of establishing a serum bank versus specific serological investigation to estimate infection rates and levels of susceptibility to major infectious agents.
- Scottish Government should develop a framework for dealing with the governance and ethical issues related to outbreak investigation.
- HPS should review the scope for further developing the monitoring of mortality indicators in health protection.
- HPS should seek to strengthen the training, support and capability for field epidemiological investigations.

4 Virology and bacteriology

4.1 Background

Influenza A(H1N1) was a new strain of the virus for which no diagnostic test was routinely available at the start of the pandemic. This had to be developed rapidly and disseminated to virology laboratories throughout the UK. In addition to underpinning public health and healthcare responses, virological testing was vital to monitor whether the virus was mutating and if it was becoming resistant to antiviral drugs. The UK virological surveillance programme was composed of two elements: antigenic and genetic analysis of influenza isolates and genetic characterisation of influenza viruses. In addition there was a need to screen respiratory specimens for the presence of other strains of influenza or other types of viruses.

Virological investigations are undertaken on a regional basis across Scotland in Glasgow, Edinburgh, Dundee, Aberdeen and Inverness. These laboratories participate in recognised national quality assurance schemes and all participate in the UK Clinical Virology Network. During the pandemic, each of these laboratories provided testing services to assist in the identification of influenza A(H1N1).

The West of Scotland Specialist Virology Centre (WoSSVC) provides an enhanced specialist respiratory virology service to support the HPS surveillance of seasonal influenza including molecular sequencing of novel viruses or viruses from patients with unusual clinical presentations each season. It also undertakes genetic sequencing on approximately 100 samples of influenza viruses each year. This has enabled WoSSVC to identify novel influenza virus subtypes for clinical diagnosis and to support surveillance and public health management of cases and clusters.

At the start of the pandemic, there was a need for rapid testing of samples from patients suspected to have been infected with the new virus. This need continued for the duration of the containment phase response when laboratory confirmation was a component of the case definitions. WoSSVC has an established link with the UK National Influenza Laboratory at HPA Centre for Infections for further testing on novel samples. The HPA laboratory is accredited by WHO as a reference laboratory for influenza strains and participates in the global network to monitor and reduce the impact from influenza. They assure the quality of assays for detecting influenza strains and confirm results of public health significance. HPA under the International Health Regulations inform WHO of these. This link enabled independent confirmation of Scottish laboratory results and facilitated the development of further specialist testing capability.

A much larger number of microbiology laboratories are in place to deal with the wide range of bacteriology samples submitted on a day to day basis and these microbiology labs are supported in turn by a number of Scottish or English Reference Laboratories specialising in specific pathogens.

4.2 Objectives

During the pandemic, the primary objectives of the virology and bacteriology laboratory services were:

- To provide testing to support clinical management, including;
  - confirmation of clinical diagnoses;
  - identification of secondary infections.
- To provide testing to support surveillance, including;
  - monitoring extent of pandemic infection;
  - corroboration of data from clinical surveillance schemes;
  - molecular surveillance (to identify mutations and antiviral resistance);
  - monitoring of secondary infections.

4.3 Methods

4.3.1 Diagnostic Testing

A rapid laboratory testing service was initially required urgently to process samples from patients based on the HPS algorithms and case definitions. There was no available specific assay for this new strain of influenza at the time of the first suspected case in Scotland. The initial testing arrangements involved local determination of a positive result but relied on confirmation by the HPA CfI. After this initial duplication of results there was a move to local laboratories reporting on their own confirmed cases.

WoSSVC developed a test for influenza A(H1N1) (Carr et al., 2009) although verification was required by further testing undertaken by UK National Influenza Laboratory at HPA Centre for Infections and formally communicated by HPA to ECDC/WHO. This laboratory identified the first cases returning to Scotland from a holiday in Mexico. A few days later came confirmation or person to person spread and the decision to use the WoSSVC laboratory for Scottish testing of samples until the other Scottish laboratories had received/developed a test that would detect the novel swine influenza. Further laboratory developments over the period of the pandemic within Scotland, enabled a number of tests to run simultaneously to detect all influenza A viruses and typing for influenza A(H1N1) (Gunson et al., 2010).

Because this was a new virus, a high degree of confidence in reporting of positive laboratory results was needed. It was agreed that all Scottish isolates of the new virus would be subject to confirmatory testing which was undertaken at the HPA National Influenza Laboratory. This duplication of testing arrangements continued until the numbers of samples being tested no longer made this possible. After that time laboratories that were using assays assured by the HPA were able to report directly on their local testing without such confirmation (Carr et al., 2009, Ellis et al., 2009). Some continued to send positive samples for confirmation until two influenza A(H1N1) assays were locally available.

4.3.2 Sentinel Surveillance: Testing Samples Taken from those Attending their GP with ILI/ARI to Help Determine What Proportion of Illness was Due to Influenza A(H1N1) Virus

Following the move from the containment phase to the treatment phase at the start of July, one of the main objectives of the virology component was corroboration of the consultation data on presentations of ILI and ARI within primary care. This was carried out through the sentinel GP schemes and the methods for this along with results are fully described elsewhere within the report.

The sample numbers were very high during the winter outbreak and this resulted in temporary suspension of testing for a range of respiratory viruses, which would normally run through the flu season.

4.3.3 Antiviral Resistance Detection and Identification of Mutational Changes

WoSSVC undertook molecular analysis of influenza strains for local identification of unusual sequences. More detailed testing for antiviral resistance or of mutational changes associated with severe disease was carried out and validated by UK National Influenza Laboratory with additional testing undertaken by the WHO Collaborative Centre at the National Institute for Biological Standards (NIBS).

Routinely, samples taken from individuals confirmed to have influenza A(H1N1) infection in whom WoSSVC identified an usual nucleic acid sequence, were sent for antiviral susceptibility testing to the two main antivirals used in the UK, oseltamivir and zanamivir.

Detailed information on the antiviral resistant cases in Scotland was obtained by HPS via questionnaires to the relevant NHS boards in a UK investigation coordinated by HPA. The objective was to gain an understanding of epidemiologic, clinical and demographic characteristics of any oseltamivir-resistant cases, and evidence of transmission to close contacts.

4.3.4 Monitoring of Secondary Infections

In addition, to the virology testing arrangements, there was an enhanced surveillance of bacterial respiratory pathogens. The main surveillance activity has been of invasive disease caused by the most common secondary bacterial pathogens associated with influenza infection: *Streptococcus pneumoniae* (invasive pneumococcal disease), *Neisseria meningitidis* (invasive meningococcal disease), *Haemophilus influenza,* Group A Streptococci and *Staphylococcus aureus*.

4.4 Key Findings

4.4.1 Diagnostic Testing

Table 6 summarises the overall number of samples taken and the proportion positive in all patients presenting with ILI in Scotland during the containment phase. These figures are based on the regional virology laboratory returns until 2 July 2009.

Table 6: Number and proportion of Influenza A(H1N1) positive cases

Swine flu	Number	Percent
Positive	1226	9.6
Negative	8652	67.9
Not recorded	2871	22.5
Total	12749	100

Analysis to 2 July 2009 shows that *where a laboratory result is recorded (n*=9878) 12.4% (n=1226) were positive for influenza A(H1N1).

The sample source was recorded for 61.4% (n=6067) of cases. The following were the results by source:

- 3190 were from GPs of which 340 (10.7%) were positive;
- 586 were from hospital inpatients of which 91 (15.5%) were positive;
- 303 were from hospital outpatients of which 38 (12.5%) were positive;
- 33 were processed from A&E of which 5 (15.2%) was positive.

4.4.2 Sentinel Surveillance: Testing Samples Taken from those Attending their GP with ILI/ARI to Help Determine What Proportion of Illness was Due to Influenza A(H1N1) Virus

Results are provided in Section on Surveillance.

4.4.3 Antiviral Resistance Detection and Identification of Mutational Changes

During the treatment phase of the pandemic, the sequencing capacity at the WoSSVC was used to enable local identification of unusual genome sequences indicating mutations in selected samples of influenza A(H1N1). This was done to identify mutations known to be associated with viruses resistant to antiviral agents. Sequencing was also undertaken to identify mutations which may have been associated with infections that were clinically more serious. These results were matched with relevant clinical data, contributing to surveillance of the new virus. All of the unusual viral genome sequences identified in Scotland were referred for confirmation to the UK National Influenza Laboratory or to the WHO Collaborative testing facility based at the National Institute for Biological Standards (NIBS) (Harvala et al., 2010).

A total of 5,629 pandemic influenza viruses were analysed for the marker commonly associated with resistance to oseltamivir in seasonal influenza (H275Y) during the pandemic period by the UK National Influenza Laboratory; a total of 40 samples were found to carry this mutation in the UK.. Of the 40 antiviral resistance (AVR) cases seen in the UK, 9 were from individuals resident in Scotland as reported to HPS, with an additional 2 individuals identified as having partial antiviral resistance i.e. less than 50% resistant to oseltamivir on antiviral susceptibility testing (Harvala et al., 2010).

HPS undertook further investigations for those patients for whom it was found that their infections had been caused by viruses resistant to antiviral agents. NHS boards' public health teams cooperated in obtaining detailed clinical and epidemiological information about these patients. The information obtained was shared within the UK as part of continuing epidemiological surveillance of antiviral resistance patterns.

As at 22 March 2010, completed questionnaires had been received for 7 out of the 9 AVR cases in Scotland. NHS board of residence was known for seven cases: three were from NHS Lothian, two from NHS Dumfries and Galloway, one from NHS Ayrshire and Arran and one from NHS Lanarkshire. Six of the Scottish cases were known to have underlying risk factors.

4.4.4 Monitoring of Secondary Infections

From routine surveillance, there was no observed increase in the numbers of those pathogens associated with secondary infections during the influenza A(H1N1) pandemic.

Information on secondary bacterial infections in confirmed cases was obtained via the new hospitalised surveillance scheme showed that 345 (22.4%) had a secondary bacterial infection. The age range was 0-94 years. More than half of the cases (203; 58.8%) were known to have an underlying risk factor and 27 cases (7.3%) died. Admission to ITU was required for 47 patients (13.6%) and admission to HDU for 26 patients (7.5%).

A small number of confirmed cases were recorded as having concurrent invasive respiratory bacterial infection. All of these were confirmed via blood culture; four *S. pneumonia*, four S. *aureus* (of which two were MRSA) and two *N. meningitidis*. Three (30%) of the cases were female, two (20%) were known to have underlying medical conditions and four (40%) died. The age range was 12-72 years (mean 46 years, median 40 years) across seven NHS boards (three in NHS Greater Glasgow and Clyde, two in NHS Lothian, one in NHS Ayrshire and Arran, one in NHS Fife, one in NHS Grampian, one in NHS Lanarkshire and one in NHS Tayside). Three (30%) required admission to ITU and one (10%) to HDU.

4.5 Lessons Learned

The following are the key issues fed back from the three debriefings:

What went well

- Rapid development and roll out of molecular based tests in Scotland.

What should be improved

- Surge capacity of virological laboratories.
- Rapid development of serological tests and protocols.

4.6 Discussion

4.6.1 Limitations

In June 2009, during the latter part of the containment phase, all Scotland's virology laboratory services came under severe pressure. The WoSSVC was particularly stressed because of high demand for influenza testing arising from increased levels of influenza-like illness in the south of Glasgow. The laboratory responded by increasing its capacity and throughput however this was insufficient. For several weeks it was necessary to send samples for testing at the HPA virology laboratory in Manchester.

The rapid detection of pandemic influenza A(H1N1) 2009 by the WoSSVC and its confirmation by the HPA Cfl Colindale is a testament to the expertise of the virology network that exists in Scotland and the rest of the UK. Testing systems were rapidly developed and rolled out to expand the availability of testing across the UK by regional laboratories.

Despite huge demands that placed intolerable pressure particularly on the virus laboratories at the epicentre of geographical 'hot-spots' the laboratories activated special arrangements to maximise the number of results they could generate. Whilst this led particularly during peak containment phase activity to some communication difficulties in ensuring laboratory results were made available in a timely fashion overall the system worked well. The clinical virology network communicated new developments extremely effectively with the mutual support provided greatly appreciated. Of particular note was surge capacity assistance provided for a short time by the HPA Manchester laboratory.

The experience of the pandemic has shown that effective IT systems for notifing results can be as important as laboratory capacity for testing. Pressure on WoSSVC was partly relieved by access to the electronic data warehouse system (SCI) provided by Greater Glasgow and Clyde NHS Board. This allowed GPs and other who where not in the board area to access results on their patients.

4.6.2 The Virology of the Pandemic in Scotland

The adoption of testing of certain cases of pandemic influenza A(H1N1) 2009 for evidence of antiviral resistance in October and November demonstrated that only a small proportion of confirmed cases had evidence of any AVR to the antiviral oseltamivir. This was particularly important in the large input that the UK made to the description of the nature of this resistance and the finding of association with patients who were immunocompromised. This led to changes in clinical management in immunocompromised cases to afford individual public health protection from the worst of this infection.

Antiviral resistance was found in nine cases in total (Harvala et al., 2010). Whilst the UK identified more antiviral resistant cases proportionately that any other country; Scotland and Wales identified a disproportionate number within the UK. In Wales this was due to the investigation of an outbreak in a haematology unit. Unlike Scotland the rest of the UK

retained an antiviral resistance testing policy predicated on clinical need rather than testing of all hospitalised cases. This may explain why Scotland identified a disproportionate number of cases within the UK total.

The virology service also remained alert to the emergence of any clinical situations indicative of concern that the pandemic strain could be exhibiting increased virulence. Such locally detected clinical problems were subjected to molecular sequencing in the WoSSVC and later onward submission to the WHO Collaborative Centre for more detailed molecular and culture analysis. Consideration should be given regarding the future arrangements to maximise the utility of these arrangements.

Corroboration of clinical presentations of ILI was an important part of the response. The usual sentinel scheme in place was extended to provide a more complete representation of the Scottish population. The number of samples requested from the sentinel GPs was designed to provide sufficient statistical power to enable anaylisis of the distrubution of swab positivity by NHS board. In addition, as a result of this surveillance, estimates of total numbers of people in Scotland with influenza A(H1N1) based on age specific consultation rates from the all Scotland influenza surveillance reporting scheme were able to be produced and reported. These estimates provided a useful overview of the emerging situation in Scotland within the community despite a number of limitations of the data.

4.7 Conclusions

The objectives for the virology and bacteriology services were:

- To test samples for influenza A(H1N1) infection in suspected cases in the containment phase;
- In the treatment phase, to test samples taken from those attending a sentinel General Practice with ILI/ARI to help determine what proportion of illness was due to influenza A(H1N1) virus;
- To detect mutations, antiviral resistance by molecular analysis including sequencing to detect secondary infections;
- To detect secondary infections.

Despite considerable pressure on them, these objectives were largely achieved.

4.8 Recommendations

Management of the Seasonal Influenza Immunisation Programme

- NHS boards should establish a managed clinical network for virology.
- Scottish Government should review the need for a specialist lead laboratory for respiratory viruses in Scotland.
- HPS should determine remaining levels of susceptibility to influenza A(H1N1) in the population.

Managing a Future Pandemic or Like Event

- NHS boards should review the current and surge capacity requirements for virological services.

The Development of Health Protection Services in Scotland

- Scottish Government should ensure access to molecular testing facilities is distributed more widely across NHS boards.

5 Risk Assessment

5.1 Introduction

Influenza A(H1N1) was a novel strain of the virus first detected in the USA and Mexico a matter of days before the first cases were seen in Scotland. As such there was considerable uncertainty about the size, speed and seriousness of a potential pandemic arising from this emerging infection. A key process in the management of the pandemic therefore was assessing the risks from the virus i.e. the probability of it becoming widespread in the population, the severity of its impact on health and the likely effectiveness of measures to control spread and reduce the impact.

To help assess this, evidence was required to be gathered on: (ECDC 2009)

- infectivity i.e. how the virus was transmitted and whether this was the same as seasonal flu virus strains
- reproduction rate i.e. how many new cases each case of infection could infect
- immunity i.e. was there any previous immunity to the strain in the population from prior circulating strains of influenza and to what extent did this protect the population
- virulence i.e. what proportion of those infected developed disease
- spectrum of disease what proportions of cases were mild and severe and was the nature of the illness difficult to differentiate from like infections
- case fatality rate how many people infected would die
- effectiveness of interventions in particular immunisation and antiviral drugs.

Information on these factors needed to be accumulated quickly. The steps taken in Scotland are outlined in the epidemiology and investigation section. In the initial stages, much depended on information flowing from Mexico and later from the Southern hemisphere. Due to the paucity of data and the potential for the pandemic to have a very considerable impact on health, a precautionary approach was taken in the initial stages of the pandemic with actions being taken and planned for a range of severity up to and including a worst case scenario. It was important that this was modified as more information became available and was assessed. In particular the phasing and coordination of control measures required to be guided by risk assessments and consequent scientific advice.

In recent years our understanding of the epidemiology of infections and their control has been greatly increased through mathematical and statistical modelling. This approach sets out a representation of the essential aspects of how a disease is spread, its impact on health and how this may be reduced; describes these by a set of variables and defines how these variables relate to each other through a set of equations. These relationships are based on probability distribution. Once set out, the variables in the model can be calibrated as more data becomes available and more evidence on the relationships between the variables is accrued. By running the model, the probability of certain outcomes can be described. Modelling was an essential feature of risk assessments prior to and during the pandemic.

Risk assessments primarily took place at two levels in the management of the pandemic. The first was at a UK level through the formal scientific advisory process coordinated by the Scientific Advisory Group on Emergencies (SAGE). A specific group – the Scientific Pandemic Influenza Advisory Committee's Sub group on Modelling (SPI-M) had been established prior to the pandemic to model it and advise on implications for policy. This group brought together representatives from four organisations in the UK who had developed models related to the pandemic. A representative from HPS sat on the SPI-M group during the pandemic. The Joint Committee on Vaccination and Immunisation (JCVI) advised on vaccine policy and fed this in to Government ministers via SAGE. The work of SAGE and JCVI was complemented by the Pandemic Influenza Clinical and Operational Advisory Group which provided clinical advice.

The second level was at NHS boards in Scotland where local risk assessments were carried out when clusters or outbreaks of influenza A(H1N1) had been detected. In particular these related to decision making during the containment phase on interventions to reduce the extent and rate of transmission of the emerging infection through measures such as post exposure prophylaxis and school closures.

There was no formal risk assessment mechanism which operated solely at a Scotland-wide level. HPS and Scottish Government assessed results from the UK based risk assessments coordinated through SAGE, for their implications to the Scottish situation. Interpretations were formulated and based on these, advice was provided to Scottish Government and others. Two particular Scottish issues required consideration: firstly the different pattern of cases of infection during the first stage of the pandemic and the evidence that these were no longer being contained and secondly, the impact of the earlier reopening of schools in Scotland on the likely spread of the virus in the wider population.

5.2 Objectives

- To assess the probability of the influenza A(H1N1) virus being widely circulated in the Scottish population and its likely impact on health.
- To assess the likely effectiveness of measures designed to prevent or reduce the rate of transmission or mitigate the impact of the virus on health and advise on the implementation of these measures.
- To review and interpret the implications for Scotland of UK-wide risk assessments.
- To advise the Scottish Government, NHS boards and others on levels of risk and the actual or likely impact of control measures.

5.3 Methods

5.3.1 Modelling the Pandemic

SPI-M met regularly throughout the pandemic and brought together the results from the modelling work being undertaken in the UK. The group was tasked with interpreting the results from the models and associated evidence to provide for SAGE, as far as possible, a real time indication of the nature, extent and impact of the pandemic. It also drew together epidemiological and other data on the nature of the pandemic, summarised these and gave information on factors such as estimated case fatality, clinical attack rate and hospitalisations. The implications of these numbers were assessed for planning assumptions and consensus statements produced. Updated planning assumptions were released on three occasions during the pandemic: July, September and October 2009.

5.3.2 Review of the Epidemiology of the Pandemic in Scotland and its Risk to the Health of the Scottish Population

As indicated previously the influenza A(H1N1) pandemic in Scotland in its early stages showed important differences to that seen in other parts of the UK. The first case and the first transmission in the UK were detected in Scotland. Initially the age distribution of confirmed cases was older than in the rest of the UK. There was evidence that community based transmission was occurring in parts of Scotland earlier than in other parts of the UK. Subsequently the earlier reopening of schools after the summer vacation had an impact on the likely further spread of the pandemic after the summer. All these meant that the results of the UK wide risk assessment models had to be further interpreted at a Scottish level to provide advice to the Scottish Government which complemented that coming from SAGE.

5.3.3 Locally Based Risk Assessments

During the initial stages of the pandemic the key strategic objective was to try to decrease the speed of transmission of the virus in the community. This entailed the early detection of cases of infection and their close contacts and putting in place measures to reduce the probability of transmission from them to others in the community. In particular, priority was placed on identifying children who were cases or close contacts of cases of influenza A(H1N1) and considering closing the schools or nurseries which they attended. Risk assessments were undertaken to assess factors which might increase or decrease the potential for spread of the illness in these and other relevant enclosed settings. Factors included the nature of the illness, the type and duration of exposure to the virus and the nature of environment in which such exposures took place. Based on a review of these, decisions on control measures would be taken. The responsibility for these risk assessments rested with the NHS board in which the cases were detected. To ensure a consistency of approach across the country, HPS coordinated and provided support and guidance for the local risk assessments.

5.4 Findings

5.4.1 Modelling the Pandemic

Table 7 summarises the key planning assumptions for pandemic influenza issued by UK Departments of Health during the pandemic. These were based on a consensus reached at SAGE on worst case scenarios for the event derived from the different models described above.

Table 7: Summary of key UK planning assumptions for pandemic influenza

Summary of key planning assumptions for pandemic influenza issued by UK Departments of Health, based on reasonable worst case scenarios			
	July 2009	**September 2009**	**October 2009**
	Assumptions for first major pandemic wave	**Assumptions to mid-May 2010**	**Assumptions from 1 October 2009 to mid-May 2010**
Clinical attack rate	30% of population	Up to 30% of population	Up to 12% of population
Peak clinical attack rate	6.5% of population per week	Up to 6.5% of population per week	Up to 2.5% of population per week
Case hospitalisation rate	2% of clinical cases	Up to 1% of clinical cases	Up to 0.5% of clinical cases
Case fatality rate	0.1 to 0.35% of clinical cases	Up to 0.1% of clinical cases	Up to 0.1% of clinical cases
Peak absence rate	12% of workforce	Up to 12 % of workforce	Up to 5% of workforce

The worst case scenario rates were predicted to be lower in the second set of assumptions compared to the first and in the third compared to the second.

In retrospect, the impact of the pandemic was roughly in line with the last worst case scenario published in October 2009, 6 months after its commencement (see table 8).

Table 8: Planning assumptions compared to the estimated rates

Planning Assumption	**Estimated rates**	
October 2009	**International**	**Scotland**
Clinical attack rate Up to 12% of population	11% WHO writing group (Bautista et al., 2010);	16% (assuming only 10% of symptomatic patients attend GP)
Case Hospitalisation rate Up to 0.5% of clinical cases	2% WHO (Bautista et al., 2010)	1.9%
Case fatality rate Up to 0.1% of clinical cases	0.04% (Pebody et al., 2010)	0.07% of those estimated to have consulted

The main aim of the treatment phase was to mitigate the impact of the infection on health and to this end the influenza A(H1N1) immunization programme was implemented from 21 October 2009. With the growing evidence that the virus caused mild disease in the great

majority infected, the priority became to assess its impact on those most at risk of severe illness because of underlying chronic medical conditions. As was noted in other countries, it became clear in Scotland that pregnant women were at increased risk of influenza A(H1N1) infection compared to that from seasonal influenza strains. Evidence on the likely effectiveness of immunising those with at-risk conditions, including pregnancy, was assessed by the JCVI on 8 October. The results of modelling corroborated the earlier decision that immunising these groups was likely to be effective and cost-effective (Baguelin 2010).

5.4.2 Review of the Epidemiology of the Pandemic in Scotland and its Risk to the Health of the Scottish Population

By the start of June 2009, the growing number of sporadic cases, the reproductive number in the Dunoon outbreak being between 1.5 and 2 and the detection of tertiary chains of transmission indicated that sustained community transmission was occurring in parts of Scotland. The implication of this was that the containment measures were not fully effective. HPS advised the Scottish Government of the situation which had also arisen in parts of England. The Scottish Government agreed with its UK counterparts to refine the UK control strategy to allow a differential approach to be taken in different areas of the country according to the spread of the virus. This occurred on 11 June, with the modified containment approach lasting until 2 July.

Schools in Scotland commenced closing for the summer vacation on 26 June. After that date, a steady reduction occurred in the number of confirmed cases reported in all ages, the greatest reduction occurring in those ages 5-16 years. In the treatment phase (from 11 July), the surveillance of the infection in the community became based on monitoring GP consultation rates. From the end of April 2009 when influenza A(H1N1) was first reported in Scotland, overall consultation rates to the end of August did not demonstrate any marked increase. Of note however, was that there was not the same decrease in the consultation rate for influenza-like-illness as observed in previous years and evidence that the virus still continued to circulate on a limited basis.

By 20 August all schools in Scotland had reopened. GP consultation rates for influenza-like-illness started to increase and by 22 September were as high as in November 2008 (immediately before their peak in that flu season). The increase in consultation rates (particularly in school age children) was closely monitored. It was not reflected in any significant 'across the board' rise in overall reported levels of absence in staff or pupils. When these did occur in individual schools, they relatively rapidly returned to normal. To help ascertain if this phenomenon was due to the infection being widespread but its impact on health mild with therefore with few consequent clinical cases, HPS planned to undertake serological studies in affected secondary schools. The aim of these was to better assess the ongoing risk to health and advise Scottish Government especially on to help decide on what levels of healthcare preparedness were required over the winter. However collaboration from either schools or NHS boards was not forthcoming. As schools reopened earlier in Scotland than other parts of the UK, evidence of the impact on indicators of the infection rates were fed back to SPI-M and SAGE and incorporated into their considerations.

5.5 Lessons Learned

What went well

- Collaboration with HPA in the collation and submission of papers to SAGE.
- Joint working with Scottish Government and HPA on the development of Scottish based risk assessments.

What should be improved

- Methods to determine the virulence of novel viruses.
- Rapid investigation of levels of immunity to novel viruses.
- Further formalisation of risk assessment methodologies (in particular modelling) at a Scottish level.

5.6 Discussion

5.6.1 Limitations

Assessing the risk from any newly detected infection is always difficult particularly with new strains of influenza when the gap between detection and widespread, global transmission can be relatively short. Much of the early information on the public health impact of the new strain came from Mexico. In retrospect, the early indications from there were not wholly representative of the pandemic as a whole. As the pandemic evolved, different international sources of data initially suggested apparently contradictory conclusions.

The mild nature of the illness meant that many people did not need nor seek help from the healthcare system making estimating the number of cases infected much more difficult. The UK epidemiological systems designed to do this had been developed to measure the initial features of a pandemic likely to be more severe as could be seen should influenza A H5N1 develop a pandemic potential. They had to be reshaped for this strain. This took time. Much of the early evidence on the impact of the virus came from rapidly designed and implemented surveillance systems. It took time to ensure that these were consistently employed across Scotland. Changes in GP reporting coincided with changes in the spread of the pandemic leading to difficulties with the interpretation of the results.

The level of background immunity was unknown in the early stages of the pandemic and thus knowledge was relatively sparse about the extent of susceptibility to the infection; the probability of widespread transmission and about the relationship of the infection to disease and complications. This impeded a more accurate risk assessment. Efforts in Scotland to address this by carrying out serological surveys in at risk groups were unsuccessful partly due to a lack of planned capacity to undertake these but also due to concerns about ethical approval.

5.6.2 Assessing the Risks to Health from the Pandemic

The risks to health from the pandemic were much less than the worst case scenario which informed planning for the pandemic. However by October 2009, they were assessed as being broadly comparable to what was seen. The reasons for the lag period in achieving this are set out above.

The factors, which needed to be taken into consideration in assessing the risk, are detailed at the start of this section. Much is now known about these factors and how these relate to seasonal flu strains. The secondary attack rates have ranged from 7-13% (ref ECDC 2009). The reproduction number is estimated to range from 1.1 - 1.8 (Nishnura 2009). Older people are less affected due to the presence of immunity from having been exposed to an earlier influenza A(H1N1) infection. In serum samples obtained in 2008 in England, antibody titres showing evidence of previous infection, were found in over 80% of those aged more than 80 years (Miller 2010). The ratio of infection to clinical presentations for influenza A(H1N1) was estimated in children to be around 10 to 1 (Miller 2010). In Scotland the ratio of GP consultations to hospitalisations was estimated to be 1.7% compared to 3.2%, estimated ratio for other pandemic influenza A strains (Pitman 2007). Table 9 (ECDC 2009) summarises the similarities and differences between the 2008/09 circulating seasonal influenza strains and the 2009/10 pandemic influenza strain.

*Table 9: Similarities and differences between seasonal influenza strains 2008/09 and 2009 pandemic influenza A(H1N1)**

Parameter	Seasonal influenza (2008/09) A (H2N3), A(H1N1), B Viruses	2009 Pandemic influenza A(H1N1)
Highest transmission rates	All ages affected but more transmission among the young	Children highest, then young adults, quite uncommon among older individuals
Underlaying immunity (prior to immunisation)	Some immunity in most age groups, highest in those immunised, lowest in young children	Pre-exisiting immunity in older people (born after around 1950)
Clinical features	Simple and complicated influenza disease. Viral pneumonia very rare	Many mild cases, simple and complicated influenza disease. Some more diarrhoea than usual. Viral pneumonia and Acute Respiratory Distress Syndrome occurring
Asymptomatic infections	Occur in about 30% of people infected	Seemingly in a higher proportion than for seasonal inluenza
Antiviral resistance for neuraminidase inhibitors	Very common in A(H1N1), rare in A(H3N2) and not present in B	Rare in the pandemic strain
Effectiveness of seasonal influenza vaccines	Depends on degree of match between vaccine and circulating virus	Expected to be very high because perfect match between virus and vaccine

*Source: ECDC

On the whole, the impact of the novel influenza A(H1N1) strain was not radically different from other influenza A strains. The first main difference was the presence of relatively high levels of immunity against it in older sections of the population. This meant that transmission was mainly among younger age groups, who are on the whole are a healthier population. The second was the high ratio of infected to clinical cases which meant that only a relatively small proportion of those who were exposed to the virus actually became ill and

contacted the healthcare services. However it appears from evidence from both Scotland and internationally that compared to other influenza A strains, the pandemic strain was associated with a relatively high proportion of hospitalised cases having required critical care (12% of hospitalised cases in Scotland having been admitted to HDU or ITU). The impact on pregnant women also appears to have been relatively greater.

The case fatality rate in Scotland appears higher than that for England and Wales. This may be due to differences between the methods used to estimate the number of clinical cases in the respective countries and is the subject of further examination by the health protection bodies across the devolved administrations.

5.7 Conclusions

The objectives of the risk assessments were:

- To assess the probability of the influenza A(H1N1) virus being widely circulated in the Scottish population and its likely impact on health.
- To assess the likely effectiveness of measures designed to prevent or reduce the rate of transmission or mitigate the impact of the virus on health and advise on the implementation of these measures.
- To review and interpret the implications for Scotland of UK-wide risk assessments.
- To advise the Scottish Government, NHS boards and others on levels of risk and the actual or likely impact of control measures.

With regard to the first this was largely achieved by October 2009, some 6 months after the pandemic commenced. It took that long to collect and assess the evidence necessary to accurately estimate risk. In particular, investigation to estimate the proportion of those infected who became clinically unwell took time. How this can be expedited should be a matter for further review at a UK level.

Evidence of the likely effectiveness of interventions against the infection obviously took time to accrue. A major gap in predicting the likely effectiveness was the few studies of the impact of post exposure prophylaxis on reducing secondary attack rates. This should be remedied.

HPS and colleagues from the Scottish Government Health and Wellbeing Directorate reviewed the outputs from risk assessments with regard to their applicability to the Scottish situation. It was recognised during the Pandemic that there was a need to improve the interface with those working on Civil Contingencies and Scientific Advice across all Scottish Government Departments

5.8 Recommendations

Managing a future pandemic or like event

- Scottish Government should review the scope for and role of modelling in assessing risks to public health during the response to a major public health incident.
- Health protection organisations should develop methodologies for rapidly assessing the virulence of new and emerging organisms.
- Scottish Government should review how the assessment of specific risks to Scotland's health can be better incorporated into UK modelling during a major public health incident.
- Scottish Government should consider the production of 'most likely' in addition to 'worst case' scenarios in planning assumptions.

6 Control Measures

6.1 Introduction

The flu virus is spread through close human to human contact usually via droplets being emitted through one person's nose and mouth and being breathed in by another. Touch and contact with contaminated surfaces are also important means of spread. Transmission is greater in enclosed settings. The degree of human to human contact varies according to age and behaviour. Of particular importance is the degree of mixing among children. Transmission of seasonal flu among children in enclosed settings e.g. schools, is well documented. The spread of the virus among pupils attending schools can act as an amplifier of transmission in the wider community.

Oseltamivir marketed as Tamiflu® by Roche Products Limited and Zanamivir marketed as Relenza® by GlaxoSmithKline UK are antiviral medicines licensed in the United Kingdom for the treatment and prophylaxis of influenza. They prevent the entry of influenza virus into uninfected cells and the release of recently formed virus particles from infected cells. Antivirals are not a cure for influenza but aim to prevent influenza from spreading by reducing the chance of contacts becoming infected and reduce and shorten symptoms once infected.

Antivirals were recognised as an important countermeasure to mitigate the impact of an influenza pandemic. As part of national preparedness arrangements for responding to an influenza pandemic, a national stockpile of antivirals was established. Antivirals were recommended for use in both the containment and treatment phases of the 2009 pandemic.

On 1 May 2009 the UK Government decided to implement its strategy to slow the spread of the virus for as long as possible known as the containment phase. HPS was given the responsibility of coordinating the health protection response to the pandemic in Scotland. The main agencies responsible for the implementation of measures during this period were:

- Primary Care especially general practitioners and pharmacists;
- NHS board public health departments;
- Regional virology laboratories;
- Infection control services in community and hospitals;
- Travel and port health services.

The containment phase lasted until the 2nd July. By that time it had become evident that the number of cases had grown very rapidly, there was evidence of sustained community transmission and local services especially in and around Glasgow were being placed under considerable strain. The focus therefore changed to reducing the risk of the infection in those who are most vulnerable and ensuring that services could be maintained especially those in the NHS. Emphasis was therefore switched to measures to limit impact i.e. treatment and care, infection control and immunisation. HPS was not responsible for coordinating the treatment and care response. Responsibility for this rested with the Scottish Government. HPS was responsible for guiding the infection control measures and coordinating the immunisation programme (a separate report is available on this).

6.2 Objectives

The Containment Phase

1. To reduce the rate of transmission by preventing spread:
   - from detected cases to their close contacts;
   - from close contacts to others in the community;
   - in healthcare settings;
   - in schools and like institutions and from these to the wider community;
   - in passengers on aircraft and other vessels and from such passengers to the wider community.
2. To minimise the impact on health of infection from the virus by ensuring the rapid use of therapies to halt the progression of the disease.
3. To facilitate preparedness in the healthcare and other major services.

The Treatment Phase

1. To protect those who are at most risk of serious illness or death should they develop influenza by:
   - facilitating the prompt use of effective therapies especially antivirals;
   - immunising those most at risk from the infection.
2. To reduce the transmission of the virus within health and social care premises by:
   - ensuring optimum infection control measures were put in place;
   - immunising frontline health and social care staff.

6.3 Control Measures

6.3.1 Containment

a) Case Management: detecting suspected cases, rapidly confirming if they had the virus, providing effective early treatment and requesting such cases to self isolate.

NHS board health protection teams coordinated the implementation of control measures in their own area. Case management algorithms were provided to all relevant services especially those in primary care and accident and emergency departments. Measures were put in place to distribute swabs and ensure the rapid processing of these for diagnostic testing. Antiviral therapy in the treatment doses were dispensed directly to cases to ensure their early use. Public health and primary care professionals advised cases on what infection control was required in their households including how they should dispose of waste. Cases were requested to limit their movements particularly to isolate themselves at home and exclude themselves from work. Public health and primary care professionals actively followed them up to review the progress of their infection.

To support boards, NHS 24 and HPS set up the Scottish Flu Response Centre (SFREC) on 4 June 2009. Its remit was to manage flu-related enquiries from the public; to trace in-flight contacts of confirmed cases and to assist NHS boards in the management of contacts of confirmed and probable cases. NHS 24 call handlers were trained to carry out contact management: phoning contacts of cases and referring them for issue of antiviral prophylaxis and/or a clinical assessment as appropriate. The call handlers worked from protocols and scripts developed by HPS in partnership with NHS 24.

With the move from containment to treatment the public health investigation of cases and their contacts was discontinued, and the role of the SFREC evolved to that of providing clinical management and advice to those with illness. NHS 24 assumed full responsibility for the centre. Callers to the flu-line were triaged using a specially developed algorithm and offered self care advice or onward referral for clinical assessment as appropriate. There were also a number of changes regarding the issuing of antiviral treatment and prophylaxis. Antivirals continued to be distributed from the national stockpile to single NHS board locations for local management and onward issue of the medication by prescription. Antiviral prescribing information became available from the e-Pharmacy group (13 NHS boards) or from the NHS board pharmacy team (NHS Lanarkshire) from the commencement of the treatment phase onwards and formed part of surveillance activity taking place at HPS.

In line with normal practice, during the pandemic the Medicine and Healthcare products Regulatory Agency (MHRA) monitored suspected adverse effects for oseltamivir and zanamivir. In addition, a study was undertaken by HPS to specifically evaluate compliance with antiviral treatment in school settings. To manage the Greenock cluster of cases, a nursery, a primary school and an afterschool club were closed after two pupils were confirmed as cases. The classmates were prescribed post-exposure prophylaxis (oseltamivir). A study was carried out to assess compliance; the number of children

developing adverse drug reactions (ADRs) and the reasons for stopping the course prematurely. The children were asked about compliance and adverse drug events in a questionnaire or underwent a telephone interview.

b) Contact Management: tracing the close contacts of confirmed and probable cases who may have been sufficiently exposed to the virus for them to become infected and when appropriate providing them with antiviral prophylaxis.

Contacts of confirmed and probable cases were given advice on the symptoms and signs of the infection and when to report these to public health services. Unless they became symptomatic or were assessed as being at higher risk of passing on the infection to vulnerable people, they were able to move freely. Close contacts of confirmed or probable cases were given a course of antivirals as post-exposure prophylaxis. If they became symptomatic, the dosage was increased to the treatment regime.

c) Infection Control: advice to cases and contacts on hygiene at home particularly hand hygiene, and the need to effectively clean surfaces.

In healthcare settings, emphasis was placed on the use of personal protective equipment including suitable masks and the need for rigorous hand hygiene was reiterated.

Infection prevention and control guidance for health and non-health organisations was produced and updated frequently. This involved discussion and agreement with health protection agencies and organisations across the UK. All areas of guidance needed to be assessed based on emerging evidence especially the use of FFP3 masks, the inclusion of nebulisation within a list of aerosol generating procedures (AGPs). As nebulised therapy is a common first line treatment for patients presenting with respiratory symptoms, this use of FFP3 respirators resulted in a rapid drain of supplies. In order to preserve FFP3 respirator provision, HPS recommended to NHS boards, safe working practices to minimise the need for the use of FFP3 respirators.

d) Port Health and Travel: suspected cases and confirmed cases who had recently travelled in aircrafts or ships returning from affected areas were reported and other passengers on the flight followed up if considered to be close contacts.

These contacts were managed as close household contacts. Airport and seaports were put on an alert about this situation. Communcations were maintained with the airlines and when appropriate with travel companies.

At the beginning of the containment phase, the first cases were mainly travel associated and the main bulk of contact tracing was mainly passengers on the same flights as symptomatic cases. This measure required collaboration from a number of organisations, including the travel teams at HPS and HPA, NHS board health protection teams and airline companies. This ensured that the algorithms, advice and guidance were provided and also reviewed, consulted on and updated regularly. Passenger manifests made available when required, for tracing of contacts for offer of antiviral prophylaxis.

There were a number of changes to the case and contact definitions over the first few weeks which resulted in greater numbers of passengers on flights being considered as contacts due to the inclusion of UK domestic flights. The management of passenger contact was initially managed by NHS boards and HPS. However this was altered during the first few weeks on the creation of a flight centre at HPA (Newcastle). The flight centre subsequently dealt with contacting airlines for flight manifests and shared data with HPS and NHS boards with the increasing involvement of SFREC.

Special arrangement were put in place for the off shore industry. Liaison was established with the medical services providing infection control, and case management to those working on oil rigs and in related settings.

e) School and Institutional Closures: When a probable or confirmed case occurred in a school setting, a risk assessment was undertaken. In addition to managing the close contacts, consideration was made to temporalily closing the school. Decisions to close individual schools were locally determined with close liaison being established with local authorities and head teachers.

Actions resulting from risk assessment included the offer of prophylaxis to pupils and teachers who were deemed as contacts of a case. Schools were fully closed for periods of a week or sometimes depending on the setting (secondary schools), a year group was excluded for a period of a week, and occasionally this was followed by full closure of the school. The involvement of the local authorities in conjunction with the health protection teams was vital to ensure that operational issues involved in school closures were addressed.

Communication with all parties was vital and letters and leaflets were distributed by health protection teams to the parents of children involved to explain the situation and the resulting actions.

f) Outbreak Management: When clusters of cases were detected, the links among them were explored to discern if exposure to the virus might have occurred in enclosed settings were the cases had mixed. When these were detected, risk assessments were undertaken and appropriate action followed through.

g) Public Education on Hygiene: The UK Government produced a series of social marketing measures primarily designed to reinforce the importance of hygiene with regard to respiratory hand and the need to wipe surfaces.

6.3.2 Treatment phase

a) Immunisation Programme: The full report on the immunisation campaign is provided in a separate document detailing how and to what degree of success the influenza A(H1N1) immunisation programme was carried out.

.b) Cluster and Outbreak Management: during the treatment phase the focus on cluster and outbreak management changed to specific high risk situations particularly in healthcare institutions or those where those at higher risk e.g. those with severe physical disabilities, congregated.

c) Infection Control: the importance in good hygiene in healthcare settings became even more important as the number of cases being admitted to hospitals grew. Individuals with underlying, chronic illness and pregnant women experienced more life threatening symptoms and were more likely to require hospitalisation. The infection control guidance was therefore tailored to take this into account e.g. ICU/HDUs and general wards.

6.4 Key Findings

6.4.1 Containment Phase

a) Case and Contact Management

There were 1,409 confirmed cases reported to HPS during the containment phase. This is an underestimate given that surveillance was suspended for a number of days in Greater Glasgow and Clyde. It is not known how many of these received and completed their treatment course of antivirals.

The total number of close contacts requiring intervention is not known. SFREC supported three NHS boards: NHS Highland, NHS Lanarkshire, and NHS Greater Glasgow and Clyde in the management of 1200 contacts relating to 270 confirmed cases, a ratio of 3.4:1. This suggests that the number of contacts may have been in the region of at least 4,800 individuals.

During the containment phase, the total number of people recorded as having been prescribed antivirals (either as treatment or prophylaxis) by their GP is 2,340, of whom 79% lived in the Greater Glasgow and Clyde board area. This does not include antivirals prescribed by public health, hospitals or out of hours services. This total is an underestimate; based on data from pharmacies it is estimated that 27,000 doses were issued for use during the containment phase.

Up to and including 19 January 2010, MHRA received a total of 1066 reports of suspected adverse drug reactions (ADRs) for oseltamivir of which 58 (5.4%) were reported from Scotland and a total of 34 reports for zanamivir, of which 4 (11.8%) originated in Scotland. No new safety issues were identified from the data received in this period and the balance of risks and benefits for oseltamivir and zanamivir within their licensed indications remained positive throughout the pandemic.

One specific study undertaken in Scotland, was conducted in children in a Greenock school. This study looked at the experience of the use of antivirals in school children and involved contacting the parents of these children. There was a high response to the Greenock study (88%). The results reported that 79% of children were compliant with the prescribed dose

of oseltamivir. One in four children experienced at least one ADR. ADRs were defined as symptoms that started after taking oseltamivir: diarrhoea, nausea, vomiting, tiredness, loss of appetite, feeling faint, headache, rash, or stomach ache. The overall conclusion was that high compliance to prescribed oseltamivir is achievable in young children (E van Velsen, Scottish Medical Journal in press).

b) Infection Control

The HPS Infection Control Team were required to answer questions explaining the rationale for national pandemic influenza policy recommendations. This included clarification of:

- The safe disposal of face masks by patients: confirmed, probable or possible cases of influenza A(H1N1).
- The quality of surgical face masks and their ability to be 'fluid repellent' as specified in the national pandemic flu guidance.
- The varying lists of Aerosol Generating Procedures (AGPs) as specified by CDC, WHO and UK pandemic flu guidance.
- The management of healthcare workers returning from countries in which sustained transmission was occurring and who did not meet the case definitions.
- The need for eye protection when caring for patients who are confirmed, probable or possible cases of influenza A(H1N1).
- The fit-test failures of FFP3 respirators advocated for use when undertaking AGPs and/or when caring for patients with severe respiratory illness as specified in the HPS algorithms and guidance at that time.

The main concern, and by far the largest proportion of enquiries received from colleagues in the service, was in relation to the fit-test failures of FFP3 respirators (up to 50% failure rates in some NHS boards). On initial investigation, it was thought that the fit-testing procedures were not being followed correctly (CMO(2009)4); however, it became apparent that having limited alternatives to the 3M 1863 (universal size) respirator available in the national stockpile hindered the success rate of FFP3 respirator fit-testing across NHS Scotland. This situation may have been avoided had inter-agency consultation and collaboration taken place as part of influenza pandemic pre-preparedness. The composition of the national stockpile in Scotland was subsequently altered to include the 8835 respirator which was available in two sizes.

In addition to this issue, HPS included nebulisation in the list of AGPs (consistent with the WHO pandemic flu guidance), necessitating the use of FFP3 respirators by healthcare workers caring for patients requiring this procedure. As nebulised therapy is a common first line treatment for patients presenting with respiratory symptoms, this use of FFP3 respirators resulted in a rapid drain of supplies. In order to preserve FFP3 respirator provision, HPS made recommendations to the NHS boards to avoid the use of nebulisation where possible (by using spacer devices as an alternative) and the implementation of safe working practices to minimise the need for the use of FFP3 respirators.

c) Port Health and Travel

Table 10 shows the number of passengers who were traced as contacts of cases by local NHS boards and HPS travel team during the containment phase. This involved telephoning each contact and arranging for them to collect antiviral prophylaxis as appropriate.

The period between 4 June 2009 and 18 June 2009 (when contact tracing for flights was discontinued), SFREC dealt with 40 in-flight contacts of confirmed cases.

Table 10: Contacts of cases on flights during containment phase

Origin	Destination	No. Scottish passengers contacted
Vancouver	London	3
Belfast	Glasgow	1
Madeira Funchal	Glasgow	2
Cancun	Manchester	2
Washington	Heathrow	1
Cancun	Glasgow	1
Cancun	Glasgow	29
JFK	Glasgow	1
Orlando	Glasgow	39
Heraklion	Glasgow	18
Limoges	Edinburgh	4

d) School and Institutional Closures

During the containment phase in Scotland, 29 educational establishments were partially or fully closed for reasons due to influenza A(H1N1). These schools were within three NHS board areas, (Highland, Greater Glasgow & Clyde and Lanarkshire)

Table 11 shows the number of school which were partially or fully closed as part of the public health response. The types of educational establishments involved ranged from nurseries, primary schools, secondary schools, after school care and outdoor educational centres.

There were considerable limitations with data available on school closures. This was due to a number of factors including the differences between local authority and NHS board boundaries and routes of reporting.

Table 11: Number of schools closed in Scotland during the Influenza A(H1N1) outbreak

Number of schools affected by closure	Partial closure	Full closure
29	7	22

e) Cluster and Outbreak Management

There was an investigation of an outbreak associated with an individual who had became ill with fever, dry cough, headache and vomiting and was admitted to Royal Alexandria Hospital, Paisley. Whilst hospitalised, the individual had undergone investigations for suspected appendicitis which had resulted in contact with nine healthcare workers during admission.

This cluster was of particular interest as there was demonstrated spread to at least three further generations of contacts (i.e. secondary, tertiary and quaternary transmission) as well as considerable evidence of transmission within a hospital environment. This indicated that this incident was a 'super spreading event' of influenza A(H1N1) and highlighted the requirement for swift clinical diagnosis of cases with implementation of required infection control precautions.

Separate supplementary reports from NHS Greater Glasgow and Clyde, NHS Highland and NHS Forth Valley have also been published with this report providing further details of the management of clusters and outbreaks of influenza A(H1N1) in these NHS boards.

6.4.2 Treatment Phase

a) Immunisation Programme

A full report on the Immunisation Programme is provided separately.

b) Cluster and Outbreak Management

There was a limited number of significant outbreaks of infection requiring public health intervention during the treatment phase.

c) Infection Control

As the pandemic evolved it became apparent that in the main, generally healthy individuals suffered mild illness whereas individuals with underlying, chronic illness and pregnant women experienced more life threatening symptoms and required hospitalisation. The infection control guidance was therefore developed relative to the setting in which it was specifically required e.g. ICU/HDUs and general wards.

The concerns about infection control expressed by NHS staff centred on:

- the management of pregnant healthcare workers in the care of possible, probable and confirmed cases;
- the infection prevention and control measures (including social distancing measures) required for influenza A(H1N1) antiviral resistant cases and their contacts;
- the relative value of surgical face masks in minimising cross infection in primary health and social care settings;
- the continuing need for FFP3 respirators during nebulisation.

6.5 Lessons learned

The following are the key issues fed back from the three debriefings:

What worked well

- Links with and contribution of the education sector in school closures.
- Contribution of SFREC to case and contact management.

What should be improved

- Arrangements for access to and re-examination of the evidence base for Personal Protective Equipment.
- Plans for response for those with special needs.
- Development of common national health protection information system to support response.

6.6 Discussion

6.6.1 Limitations

The control measures where implemented during a period of considerable uncertainty about the characteristics of the virus and its impact on health. This led to a number of limitations in how measures were developed and implemented, namely:

- The limited evidence base on the impact of the virus and in particular how far it differed from strains of flu routinely seen in the winter months, meant that reasonably guidance at first erred on the side of caution. Guidance also required to be changed relatively rapidly and frequently and at times this caused a degree of confusion.
- The adoption of a standard UK-wide approach assured consistency but led to difficulty during the containment phase. In the later stages when, particularly in the West of Scotland there were clear signs of sustained community transmission of the virus, it was recognised that the virus was not being contained. This generated scepticism in professionals about the overall approach at a time when the capacity to maintain the response was under stress.
- Although extensive testing of the pandemic plan had taken place in the pre-pandemic phase, the wide-spread mobilisation of public health and primary care resources to try and contain the virus had not been a prominent feature of these. In particular, information systems to collate data on the extent and impact of the control measures were not in place.
- As with the investigation, professionals aired a number of concerns about the ethical underpinning of control measures. The widespread use of antiviral therapy especially in children gave rise to concerns about the risk: benefit ratio. In retrospect, these concerns were not wholly founded.

6.6.1 Implementing the Control Measures

The case and contact management algorithms were reviewed and updated in light of the changing epidemiology of the disease in Scotland. While the algorithms were mainly consistent with those issued by the HPA and other parts of the UK, some changes in them led to slightly different criteria being used to detect cases. The specific changes introduced related to the observed increase in hospitalisations and admissions to ICU and the growing number of clusters in Scotland. The changes led to the increased testing of serious cases of community acquired pneumonia (CAP) anywhere in Scotland, regardless of epidemiological history, and also cases of ILI and CAP in areas with sporadic cases. This led to difficulties for SAGE and other bodies reviewing the overall UK epidemiology. These differences were analysed and where appropriate, corrected for.

In the initial stages of the containment phase, NHS board involvement in case management was characterised by unpredictable peaks of activity. This was particularly the case in NHS Forth Valley associated with the first confirmed UK cases and in NHS Greater Glasgow and Clyde associated with the Greenock cluster. Each case required intensive investigation with follow up of all contacts. As the number of cases substantially increased in the South of Glasgow, the capacity and resilience of NHS board's public health and primary care responses were stretched.

The three main NHS boards involved in the response during the containment phase were Forth Valley (for the first cluster in Falkirk), Highland (for Dunoon and the surrounding areas) and Greater Glasgow and Clyde (for Greenock and South Glasgow). Each adopted a different model of operational response, primarily based on the links among their primary care, laboratory and public health services. The outbreaks on either side of the Clyde estuary created considerable public anxiety. They required an integrated command and control structure to rapidly mobilise significant resource. This appeared to be easier in the North than the South of the estuary, most probably due to the greater number of individuals seeking investigation and management and the more complex nature of Glasgow's healthcare system.

The FF100 study which was implemented at the start of the outbreak and which included Scottish data (Pebody et al in draft) involved an observational cohort study to examine the effect of antivirals on household transmission. The results showed a 50% uptake in prophylaxis amongst contacts at four days after the onset of the household index case. The secondary attack rate was shown to be 8.1% at two weeks with a higher rate in those under 16 years compared to those over the age of 50 years. The effectiveness of antiviral prophylaxis in preventing breakthrough infection was calculated as 92% (95% CI 73 – 98%). This study demonstrated the effectiveness of antiviral prophylaxis in prevention of onward transmission of infection within household settings.

The tracing of contacts on flights caused a considerable workload, which was helped by the creation of the flight centre at HPA (Newcastle). The development of the Scottish Flu Response Centre (SFREC) for 'surge capacity' to local NHS boards, provided support to some NHS boards to complete influenza A(H1N1) investigation forms for cases diagnosed through swabbing centres and for contacting and managing airline passengers identified as close contacts of a confirmed case on a flight.

SFREC acted as a centralised resource to assist in the response to a national outbreak. NHS 24 was ideally placed as a host organisation for it and now has a model for service delivery that could be adapted for use in responding to future national outbreaks and incidents. Good communication between stakeholders was essential. There are significant resource implications to the introduction of such a centralised response, primarily in relation to the recruitment and training of additional call handling staff. The involvement of SFREC varied from board to board and was dependant on local needs due to occurrence of 'hotspots' of infection and resultant pressure on the health protection response. It had not been planned for nor exercised in the pre-pandemic phase. The need for a centralised response should be considered early in any future national outbreaks or incidents and plans and procedures developed and tested prior to their onset.

6.7 Conclusions

The main objective of the control measures in the containment phase was to reduce the rate of transmission by preventing spread especially from detected cases to their close contacts and from close contacts to others in the community. The UK adopted, more than any other country in Europe, a rigorous strategy of trying to contain the virus in the early stages of the pandemic. The evidence for such an approach was largely derived from modelling studies. Observational studies of pandemic responses are now finding that the containment phase's control measures can be effective in diminishing the rate of transmission of the virus and in reducing its impact. However the cost effectiveness of such measures remains open to question. There is a need for further evidence on effectiveness and cost effectiveness which could be gathered through international comparisons of the different approaches to responding to the pandemic.

In real life, once the strategy was implemented, there was little opportunity to rapidly modify it to reflect the different patterns of the epidemiology of the infection across the UK. In retrospect, given the evidence of sustained transmission in the community, the containment phase probably lasted longer than was strictly necessary to meet the needs of Scotland alone. However it was deemed at government level to be suitable for the UK as a whole. A constraint on the transition from the containment to treatment phases was that the details of the management of treatment phase took some time to work out and agree. In planning any future response, further thought should be given to these aspects.

6.8 Recommendations

Management of the Seasonal Influenza Immunisation Programme

- HPS and NHS boards should contribute to the NICE review of the effectiveness of antivirals in post-exposure prophylaxis and treatment of influenza infection with particular regard to seasonal influenza thresholds and outbreak management.
- HPS should lead a review of the current respiratory precautions in infection control guidance to incorporate relevant lesson learned from the pandemic.

Managing a Future Pandemic or Like Event

- Scottish Government in collaboration with its UK equivalents should review the cost effectiveness of the control measures put in place during the containment phase, compare them with those employed in other countries.
- HPS should link with its UK equivalents to further develop UK arrangements on achieving consensus on case management and related algorithms.
- HPS should link with its UK equivalents to review the scope for a single UK centre for dealing with complex flight/travel contact tracing and guidance on Travel/Port Health/ Offshore issues.
- Scottish Government should consider the implications of the restraining powers in the Public Health etc. (Scotland) Act 2008 legislative framework if there was a more severe pandemic.

7 Communications

7.1 Introduction

Risk communication is an essential to managing incidents and outbreaks. Evidence in the scientific literature indicates that not being open about risks to health puts at stake the perceived trustworthiness of the agencies involved in managing risks. Government plans for managing the pandemic therefore contained clear guidance on communication processes.

In general terms communication in health protection falls into two categories: public and service. The first concerns media handling, helplines (especially NHS 24), social marketing (publicity, leaflets etc.), web and other telecommunications, public meetings, briefings for opinion formers (e.g. politicians, journalists, special interest groups), businesses and institutions and in special circumstances, letters to the public The second concerns alerts, enquiry handling, updates for professionals, guidance on good practice, specialist reports and briefings for managers and strategic leaders. Especially important is the distribution of information to front line clinicians who deal directly with the public.

Public communications for the influenza A(H1N1) response in Scotland were led by the Scottish Government (SG) as part of a coordinated UK approach. Media handling, advertising and publicity (the 'sneezing man') were led by Government. HPS contributed to this especially by publishing a weekly report on its website.

The Scottish Government also led communications to the NHS on health protection issues. HPS supported this and was given responsibility for establishing and adjusting regular communications to public health hospital and primary care services on the epidemiology of the infection and the measures required to slow transmission and mitigate impact. It responded to requests for ad hoc communications with stakeholders as required.

7.2 Aim and Objectives

To support Scottish Governments public communication and engagement during the pandemic by:

- informing the public on the key characteristics, spread and impact of the pandemic through a public web resource;
- providing access to key academic and other scientific groups on the methods employed to monitor these;
- supporting the NHS 24 telephone helpline and call centres especially during the containment phase.

To increase awareness, knowledge and understanding of influenza A(H1N1) infection in Scotland amongst Scottish Government, HPA and NHS services by:

- reporting to Scottish Government and Health Protection Agency on the epidemiology of the infection;
- briefing NHS board health protection teams on the pandemic and the measures developed to control it;
- alerting the NHS and Government to any significant change the epidemiology, virology of the Pandemic;
- providing a timely response to ad hoc NHS enquiries;
- supporting NHS Education Scotland in developing training materials for health professionals.

7.3 Methods and Findings

7.3.1 Reporting

As discussed previously a large amount of resource was dedicated to the processing, validation, analysis and publication of information from the 25 pandemic information systems (including those utilised for the immunisation programme). The findings were interpreted and reported on, principally in the HPS weekly report. Before publication, this was shared with Scottish government for comment.

Thirty five weekly pandemic situation reports and 180 daily situation reports were produced. HPS contributed to 100 HPA UK situation reports and also ECDC situation updates.

7.3.2 HPS Website

HPS published its daily and weekly reports in the news section of its website, with guidance materials available to professionals (and media and general public) via a dedicated influenza A(H1N1) section of the HPS Website (http://www.hps.scot.nhs.uk/resp/swineinfluenza.aspx). The website recorded in excess of 6 million page views from 695 000 visitors during the pandemic response with 50 000 of these visitors viewing 150 000 page views from the influenza A(H1N1) section of the website.

A new password protected microsite was developed to support health professionals involved in the pandemic influenza vaccination programme in Scotland. The Scottish Health Protection Information Resource (SHPIR), a compendium of evidence based guidance on good practice for health protection professionals is available on a password protected website. This was updated frequently during the pandemic as guidance was published and was also used to consult with health professionals on the draft versions of these guidance documents. There were 25 000 views from 4 000 professionals to both these password protected microsites.

HPS also provides travel health advice to health professionals and the public throughout the UK via its websites TRAVAX (http://www.travax.nhs.uk) and Fit for Travel (http://www.fitfortravel.nhs.uk). During the pandemic there were the 16 million page views from 218,000 visitors to TRAVAX.

7.3.3 Meeting and Teleconferences

Frequent teleconferencing and face to face meetings with stakeholders were set up; all were minuted and reported to stakeholders. Information provided to these groups was available for cascading throughout the NHS boards

HPS acted as facilitators in establishing the Scottish arms of an intensive care network. During the containment phase, Scotland's experience in managing ITU cases was shared with a clinical network established by the World Health Organization (WHO).

In total HPS teleconferences throughout the pandemic totalled almost 4,000 hours.

7.3.4 Emails and Telephone Calls

Dedicated mailboxes were set up to ensure the effective processing of communications, including one for enquiries. Similarly dedicated telephone numbers were established. Both operated between 7 am and 11 pm, 7 days a week during the containment phase and 7 am and 7 pm in the treatment phase.

A communication network composed of email addresses of key professionals throughout the NHS in Scotland was created. Through the network, a daily update on the pandemic and information on updates to guidance, policy and background information e.g. public perceptions of risk were communicated were issued.

HPS worked closely with NHS 24 in the development and implementation of SFREC call centre (see page 85).

7.3.5 Participation in the Coordination of Public Communications

During the containment phase, HPS liaised regularly with Scottish Government and other UK health protection agencies to develop and ensure a consistency of approach in disseminating key messages about the pandemic. HPS linked with NHS board communications teams as required, to support local communications especially in areas with high levels of the infection.

HPS also liaised closely with the Scottish Government Resilience Forum especially in reviewing information on public knowledge of and attitudes to the pandemic coming from UK Government's MORI polling.

A specific Information and Resources Group, led by Health Scotland, was developed to support the Immunisation programme. HPS was a key member.

7.4 Lessons Learned

The following are the key issues fed back from the three debriefings:

What worked well

- Close involvement of board communication teams in local response.
- Communications with primary care services.

What should be improved

- Process for briefing Scottish Government.
- Clearer guidance on confidentiality.
- Development of communication plan for informing NHS responders.

7.5 Discussion

7.5.1 Limitations

The reporting arrangements were very challenging especially due to:

- the extremely short turn around time between receipt of large volumes of data (e.g. from 96% of all GP practices);
- the need for defining clearly responsibilities for the content and publication of the weekly report. These were resolved following discussion with the Scottish Government;
- coordinating the timing of release of information with Scottish Government;
- clarifying constraints on publishing clinical details e.g. on individuals who died.

NHS boards experienced at times difficulties in managing the volume of communication especially guidance changes. This was of necessity a process that required coordination in efforts to strive to maintain a consistent approach across the UK. At some points in the containment phase this resulted in changes being made every day or second day. These difficulties were addressed by the establishment of a more rigorous version control by HPS.

7.5.2 Communications

The large volume of hits on the HPS website, email enquiries and teleconferences confirm the move away from paper-based and face to face to electronic communications. The pace of technological development will no doubt accelerate this. The heavy reliance on these reiterates the need for a robust telecommunications infrastructure and resilience and contingency management.

The extent and duration of the pandemic response tested the capacity of HPS communications. Moreover, as the pandemic response developed, it became clear that to a greater or lesser extent virtually all HPS staff were involved in some aspect of communications. This reinforced the need for on-going training in both the science and technology of communications

7.6 Conclusions

HPS did not have a direct role in communicating with the public. It mainly supported Scottish Government. From the number of hits on the website it is clear that this was achieved, despite there having been considerable pressure on those charged with this responsibility.

The organisation's other main role was increasing awareness, knowledge and understanding of influenza A(H1N1) infection in Scotland amongst Scottish Government, HPA and NHS services. This entailed the development and implementation of communication systems. There were no serous failures in these and feedback from stakeholders has been positive.

7.7 Recommendations

Managing a Future Pandemic or Like Event

- HPS should review the arrangements for naming contributors to published articles, considering if delays in information could impact on the response.
- Scottish Government should review scope for expanding role of web-based information and call centres in management of health protection.
- HPS should develop plans for how a large number of hits affects web-based information services and consider if public and professional-facing websites should be developed.

8 Coordinating the Response

8.1 Introduction

In common with other emergencies, arrangements for managing the response to the pandemic had three levels: strategic, tactical and operational. At a strategic level, decisions were made on what needed to be done to enable the response to achieve its core objectives. At a tactical level, decisions were taken on how to implement what needed to be done. At an operational level, decisions were taken on the direct delivery of services to the public.

The Scottish Government was responsible for the strategic coordination and overall direction of the health response in Scotland. HPS participated in the strategic arrangements. It was involved in the scientific advisory process through being observers at SAGE, JCVI, and the SPI-M. It provided expert advice to the Scottish Government throughout the response. It acted as a link between the strategic, tactical and operational aspects of the health protection response in Scotland.

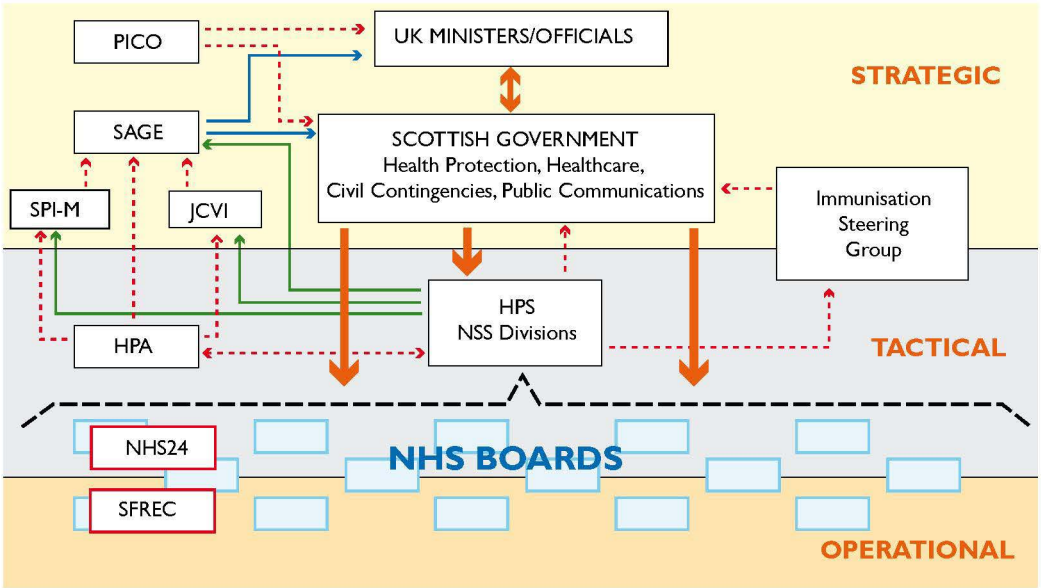
The Pandemic Influenza Clinical and Operational group (PICO) was established in advance of the pandemic to ensure that UK Health Ministers and Government are provided with timely, high quality expert clinical and operational advice to support the health and social care response. Its clinical sub-group provided on treatment and care issues. HPS was not involved with PICO.

The main role of HPS was to coordinate the tactical elements of the response especially during the containment phase. This involved close working with NHS boards. Since 2005, HPS has had the responsibility of leading the health protection management of outbreaks which affect more than one board area. The responsibilities are set out in a Memorandum of Understanding with the Scottish Government. During the pandemic, HPS reported to the Scottish Government Health Directorate. The figure below presents a chart of the organisational arrangements.

NHS boards were responsible for their local tactical elements of the response ensuring that this was consistent with the national framework, and to the operational delivery of services.

The figure below presents HPS's organisational arrangements for discharging its responsibilities during the containment and treatment phases of the response.

Figure 21: Organisational arrangements for coordinating the health protection response to the pandemic.



The structures and processes employed by HPS were as set out in its Major Incident Plan.

8.2 Aim and Objectives

To support the strategic response to the influenza pandemic and ensure consistency and cohesiveness in the tactical elements of the protection response in Scotland by:

- providing scientific advice to Scottish Government;
- coordinating and reviewing the implementation of the health protection response by NHS boards;
- establishing forums where information could be shared and dialogue take place;
- producing timely and accurate information and guidance to ensure as far as possible the response was common across board areas;
- supporting boards' tactical and operational health protection response especially to clusters and outbreaks;
- ensuring that the tactical elements of the Scottish health protection response meshed with those in other parts of the UK and international partner organisations;
- capturing lessons learnt from the health protection management of the pandemic for future reference;
- establishing and maintaining an infrastructure to support the above.

8.3 HPS Organisational Arrangements

8.3.1 Pandemic Preparedness

To prepare the health protection response to the pandemic, through its Respiratory Team and emergency planning leads, HPS contributed to or led a series of initiatives, namely:

1. Input to Planning

On behalf of the Scottish Government, HPS reviewed the board pandemic plans in 2006 to assess their consistency with the national strategic framework and identify gaps. These were shared with Scottish government and the boards. NSS, the parent board for HPS, developed its own plan. The Scottish Government strategic framework was further revised and republished in 2007. A major change was the priority given to containing spread in the early stages of the pandemic.

2. Health Protection Framework

To facilitate the boards and HPS working together, a 'Health Protection Framework for the response to an influenza pandemic in Scotland' was developed in 2005 which was aligned with the Health Protection Agency's Influenza Pandemic Contingency Plan. This was not subsequently revised. Discussions on its revision were taking place at a UK-wide level following the publication of the WHO's amended plan in April 2009 when the pandemic took place.

3. Exercises

HPS participated in 5 national and many local exercises before the pandemic. These mainly focussed on surveillance, command and control processes and caring for large numbers of severely ill patients.

4. Quality Assurance

In 2006, to describe NHSScotland's level of preparedness to respond to an influenza pandemic, HPS, on behalf of Scottish Government carried out a quality assurance exercise to review the NHS performance in developing and implementing the strategic plans and processes necessary to coordinate an overall response to pandemic influenza with a particular emphasis on health protection processes. The report highlighted the considerable progress made in the previous 3 years especially on overall strategic decision-making by NHS board, health protection and acute adult services. More work was needed on acute paediatric and primary care services.

8.3.2 Containment Phase Response

Health Protection Scotland initiated its Incident and Emergency Response Plan on Sunday 26 April 2009, following identification of the first cases of influenza A(H1N1) among Scottish travellers returning from a holiday in Mexico. This plan provided the basis for organising the health protection response during the 'containment' phase, which lasted until 10 July, a period of 11 weeks. The Emergency Coordination Room (ECR) was opened and continued to operate for the duration. Many staff within HPS were involved in the response either directly via the ECR or otherwise.

The HPS Emergency Response Team (ERT) was the coordinating group overseeing the health protection response. This was chaired by an HPS Emergency Response Coordinator (ERC) and a Deputy (DERC). The role of the ERT was to ensure the coordination of activity within HPS and to ensure effective communication and coordination with stakeholders, particularly Scottish Government Health Directorate, the 14 NHS boards as well as others including; NHS 24, SAS, NSS National Procurement and the HPA in London. The work associated with these functions was implemented by the following teams:

a) Intelligence and Surveillance

The group led the work related to monitoring, investigating and describing the epidemiology of the infection in Scotland, its complications and risk factors. It reported on these to Scottish Government, SAGE and NHS boards to help assess the risks to public health and the impact on them of interventions. Members liaised closely with four Regional Virology Centres in Scotland. A report on the public health objectives, methods and findings from this are of work are presented in the Chapter 'epidemiology and surveillance'.

b) Guidance and Expert Advice

The group's remit was to review scientific and public health evidence on the characteristics of influenza A(H1N1), its investigation and control, apply the results of this to the provision of expert advice on government policy, service delivery and professional practice and ensure the effective dissemination of that advice to stakeholders. Members participated in expert scientific groups which advised UK Government on influenza A(H1N1) and disseminated the outcomes of their discussions to HPS and other relevant stakeholders. They provided expert advice to Scottish Government on policy issues; to professionals on the management of cases of influenza A(H1N1) and their contacts, port health and infection control issues. They collated and archived all relevant discussion, and scientific papers. In doing so they worked closely with HPA especially on clinical algorithms to ensure a consistent approach across the UK. As the pandemic evolved, additional guidance was developed on the management of clusters of cases especially in households and schools more particular settings.

c) Immunisation

When the Scottish Government announced its intention to plan for immunising the whole population against influenza A(H1N1) infection a team was established to ensure readiness for the delivery of a campaign in Scotland by autumn 2009. During the treatment phase, the team became responsible with inputs from stakeholders, for ensuring ongoing effective roll-out of immunisation delivery across the population and monitoring of its effectiveness. A separate report covers the immunisation programme.

d) Communications

The onset of the pandemic created a large-scale clamour for information. Within a UK framework, Scottish Government led on public communications with HPS providing advice and input when requested. HPS also closely collaborated with NHS 24 by providing an input to Q&A materials for call handlers. This workstream underpinned the establishment of the Scottish Flu Response Centre (SFREC).

e) Information Management and Technology

Given the volume of data to be managed, the frequency of reporting and the importance of teleconferencing, a team was established to maintain equipment and hardware, develop software and provide website and graphic support.

f) Response Coordination

The ERT was responsible for maintaining a strategic overview of HPS's response and setting its and the other teams' objectives. It ensured staff were briefed and monitored and coordinated the delivery of the required actions. The team reviewed the nature and volume of enquiries. Members managed the HPS Emergency Control Room and organised shift working and meetings, which they logged. At the end of the containment phase, they carried out a debriefing. The key lessons learned from this are summarised in the relevant section on that topic.

The Scottish Flu Response Centre was launched on 4 June 2009. Its remit was:

- to manage flu-related enquiries from the public;
- to manage in-flight contacts of confirmed cases;
- to assist NHS boards in the management of contacts of confirmed and probable cases, and with other aspects of the influenza A(H1N1) response as required.

NHS 24 call handlers were trained to carry out contact management: phoning contacts of cases and referring them for issue of antiviral prophylaxis with or without a clinical assessment as appropriate. The call handlers worked from protocols and scripts developed by HPS in partnership with NHS 24. The SFREC was staffed at all times by a senior nurse manager, a team of call handlers and an admin officer. On-site expert guidance and support was provided by HPS.

Between 4 June 2009 and 5 July 2009, the SFREC dealt with 14,105 incoming calls. The average daily call rate was 440, peaking on 16 June 2009 with 808 calls. It dealt with 40 in-flight contacts of confirmed cases. It provided support to three NHS boards: managed 1200 contacts of 270 confirmed cases and completed 625 case investigation forms.

The HPS Emergency Response Team was stood down at the end of the containment phase on 10 July but its role and activities were passed on to the HPS Influenza Response Coordination Team (IRCT) centred round the HPS Respiratory Team.

8.3.3 Treatment Phase Response

The IRCT had a remit to coordinate NHS boards' health protection teams (but the intensity of that response lessened) and to liaise with Scottish Government and UK health protection bodies. The focus on surveillance and epidemiology continued but the priority in public health interventions shifted to immunisation. With the growing numbers of people seeking healthcare, the production and dissemination of advice and guidance on these issues transferred to the Scottish Government.

The IRCT maintained the infrastructure needed to support the ongoing HPS response but also sought as far as possible, to facilitate staff returning to their business as usual activities. Separate structures were set up establishing and coordinating the vaccination programme. The IRCT sought to coordinate their work with the other elements of the public health response during the pandemic phase.

When the decision to move out of containment and into treatment phase was made, HPS had to rapidly expand surveillance systems to enable the public health impact of the pandemic to be monitored. This was of the highest priority, as the only data available to inform on public health decision-making would be through these schemes. This meant that flu surveillance schemes that are normally dormant in the summer had to be revived and expanded to provide essential community surveillance data. In addition to expansion of HPS flu surveillance schemes, a number of Scottish Government-led electronic extracts were developed.

From 6 July 2009, Scotland the Scottish Government decided to extend the role of SFREC to provide clinical management. This model of working proved both safe and sustainable over several weeks. NHS 24 has retained the capability to utilise this model in future as it is flexible, responsive and can be adapted to other clinical settings with high patient demand.

The IRCT carried out a debriefing at the end of the treatment phase. The key lessons learned from this are summarised below.

8.4 Lessons Learned

The following were the key issues fed back from the three debriefings

8.4.1 Pandemic Preparedness

What worked well

- Audits of preparedness.
- Developing staffing and IT infrastructure.
- Establishing helplines.

What should be improved

- Designated coordination lead for response.
- Clarifying strategic, tactical and operation roles of responders.

Defining demands on capacity associated with activation of and initial stages of response.

8.4.2 Pandemic Response

What worked well

- Integration of health protection with other sections of public health and wider board departments.
- Maintenance of action lists.
- Single enquiry handling points and email boxes.
- Linkages between Scottish Government, NHS boards and HPS.

What should be improved

- Defining roles and responsibilities of teams and staff.
- Managing the transition from the containment to the treatment phase.
- Management of guidance development and distribution.
- Prioritising and management of teleconferences.
- Resilience if longer lasting response is required for a more serious threat.

8.5 Discussion

The Health Protection Response Framework and the lessons learnt from exercises prior to the pandemic facilitated the management of the response. However many aspects of the pandemic were unforeseen. The containment phase lasted longer than envisaged. The framework did not contain guidance on key aspects of the containment interventions. Most prior exercises did not relate to the practical and operational aspects of the phase. Measures had been planned to respond to a more severe infection. But there was an inevitable delay before the scientific evidence to confirm the relatively low virulence of the virus accrued.

The public health response in the containment phase depended on the laboratory confirmation of cases. However it took time to develop and disseminate a validated test. Decisions needed to wait for the gathering and review of evidence and where ever possible, consensus across the UK countries. But once taken, they then needed to be implemented rapidly. The lessons learned from this experience will need to be incorporated into future plans.

It is possible that the containment measures may have contributed to a slowing of the spread of the virus. But if so, this was achieved at a significant cost in terms of the resources dedicated to it by public health and primary care services. The issue of cost effectiveness is discussed further in the section on control measures.

Three NHS boards were particularly stretched during the containment phase: Forth Valley (in the first weeks of the pandemic), Highland and Greater Glasgow and Clyde (in the later stages). From the last days of May, there was evidence of sustained transmission in the Clyde Estuary and that containment was not working. At this stage the containment may have been replaced by the treatment only approach. However it was decided to introduce a phased reduction of containment measures and the new approach was implemented in these areas. Introducing and coordinating a differential approach to containment proved difficult especially in urban areas were cases could live in one area and work in another.

Despite the different rates of transmission of the infection across Scotland, mutual aid among NHS boards did not occur to any great extent. HPS provided support to the boards especially through joint working with NHS 24 in SFREC. This mechanism worked and should be considered for the future management of major outbreaks. The organisational arrangements need to be formalised. Consideration of extending the role of NHS 24 in aiding routine health protection work should be considered.

The number of cases seeking treatment in Glasgow for a few days exceeded the services' capacity for the taking of swabs. This led to a suspension of the gathering of surveillance data. The large of number of people requiring testing led to the virology laboratories having difficulties processing samples.

Through most of the treatment phase, HPS processed and analysed data gathered from 17 separate systems, and reported on a daily basis on 5 of them and on all within the weekly SITREP report. The quantity of data being handled and frequency of its use was far in excess of usual HPS activity. Primary care computing systems were rapidly modified to enable the automated collection of data on consultations and vaccine uptake. However certain aspects

of this did not go smoothly, especially the definition and processing of data on vaccination in pregnant women. These greatly stressed HPS data management processes which required a number of developments.

HPS received mutual aid from a number of its fellow divisions in NSS. A key part of the HPS remit was to rapidly collect, process and analyse data, interpret findings and communicate these to a wide range of stakeholders. ISD aided HPS greatly especially during the treatment phase with the gathering and processing of uptake data. However especially in the initial stages, the systems were not in place to manage this. The collection of FF100 data required considerable local effort by NHS boards which also needed local surveillance systems. Initially these varied across the country.

Locally developed surveillance systems were used more extensively than nationally available resources. Support from virology was essential but laboratories were severely stretched during the containment phase. There were problems at times with data transfer. Field investigations involving the taking of blood for serology were difficult to mount rapidly. Partly this was due to uncertainty about the need for ethical approval. The Framework for the surveillance and investigation of the pandemic should be revised.

NHS boards that managed clusters indicated that their arrangements worked well despite the additional workforce pressure generated by these cases. However smaller NHS boards found it difficult to cope with managing the clusters while at the same time, participating fully in national coordinating arrangements. Greater appreciation is needed of the burden placed on smaller public health teams during future pandemic responses.

Communication between public health teams with local and national partners worked well as did NHS board arrangements for disseminating information internally. NHS board communication teams played a key role in supporting the response. However, on a few occasions concern was expressed at national media being briefed ahead of NHS boards by the Scottish Government.

8.6 Conclusions

The scale of health protection response to the Scottish pandemic was unprecedented in the demands it placed on those services during the containment phase. Despite this, on the whole, pre-pandemic response arrangements appear to have been robust enough to cope with the influenza A(H1N1) pandemic. Coordination mechanisms were rapidly set up. Additional support was drafted in when required. In some cases a lack of available IT and communication equipment led to delays. Definitions of roles and responsibilities were occasionally unclear. The appointment of a coordination lead was essential in managing the containment phase locally and nationally.

Resilience was a concern. Containing a more severe, long-lasting pandemic would be difficult. Some NHS boards experienced problems in sustaining the response out of hours. Routine public health functions were disrupted. Greater resilience needs to be built in to arrangements for future pandemics. Planning should take account of more severe pandemic scenarios and address the impact of potential absenteeism on future responses.

HPS support was considered to have worked well during containment but the management of the transition from the containment to the treatment phase could have been improved. Guidance produced by HPS was considered to be excessive and occasionally unclear. Teleconference discussions could have been more focused on priority areas and reduced in number to eliminate duplication of information.

The pandemic was less severe than had been provided for in the national framework documents. However the experience of the 2009/10 pandemic did give the health protection services in Scotland an opportunity to implement and test these plans in a live setting. In managing the response, a number of issues arose during the pandemic which if they are resolved will facilitate the future management of the health protection response to a major outbreak. Key are:

- The management of the multiple data streams needed to ensure a cohesive and effective response effectively. A common approach to this is needed across HPS and the boards. The development of an information system to underpin standardised working methods in health protection is a priority.
- Policy making and implementation on the de-escalation of the response to a major public health incident including reviewing the scope for more flexible local arrangements during this phase.
- Updating the health protection framework to reflect the overall strategic plan.
- Support for NHS boards' response when they are stretched especially through building on the experience of SFREC and NHS 24's role as the national centre for telephone advice to the public.
- Guidance development and dissemination processes.

It is important to remember that the likelyhood of a future pandemic remains. There is a continuing threat from avian influenza. Pandemic viruses are unpredictable and we should remain alert.

8.7 Recommendations

Managing a Future Pandemic or Like Event

- Scottish Government should review the scope for local flexibility within a strategic framework during the health protection response to a pandemic or like event.
- Scottish Government should clarify the processes for policy making and implementation on de-escalating the response to a major public health incident.
- Scottish Government should develop a national list of prioritised public health programmes and activities to be maintained during a pandemic or like event.
- HPS should review and enhance the process of developing and disseminating guidance during a major incident including greater involvement of clinicians e.g. consultation with the Royal Colleges.

- HPS and NHS 24 should develop arrangements to re-establish SFREC for future pandemics and if appropriate other major public health incidents.
- Scottish Government should further develop joint working with primary care services in strategic planning. Contingency should be made for potential negotiations with GPs.
- NHS boards should review the timing of and need for multi-agency (e.g. SCG) meetings in future pandemics which may not be required depending on the severity of the outbreak.
- HPS and NHS boards should develop a common management infrastructure to be put in place including project management for managing future responses to pandemic influenza.

The Development of Health Protection Services

- Scottish Government should review the scope for expanding role of web-based information and call centres in management of health protection.
- Scottish Government should further clarify and formalise organisational roles and accountabilities for health protection especially relationship between HPS and boards.
- Scottish Government and NHS boards should develop and implement a health protection information system for Scotland.
- HPS should review the management and enhance arrangements for teleconferences.
- Scottish Government should review the capacity and resilience and mutual aid arrangements among boards.
- HPS should review the arrangements for naming contributors to published articles, considering if delays in information could impact on the response.
- Scottish Government should further clarify and formalise organisational roles and accountabilities for health protection.

9 Acronyms and Abbreviations

ACP	Antiviral collection point
CAR	Clinical attack rate
CCC	Civil Contingencies Committee
CCC(O)	Civil Contingencies Committee (Officials)
CCS	Civil Contingencies Secretariat
CEAPI	Committee on Ethical Aspects of Pandemic Influenza
CFR	Case fatality rate
CHR	Clinical hospitalisation rate
CMO	Chief Medical Officer
CO	Cabinet Office
COBR	Cabinet Office Briefing Room (often referred to as COBRA)
CSA	Chief Scientific Adviser
Defra	Department for Environment, Food and Rural Affairs
DH	Department of Health
DHSSPSNI	Department of Health, Social Services and Public Safety Northern Ireland
DWP	Department for Work and Pensions
ECDC	European Centre for Disease Prevention and Control
ECMO	Extracorporeal membrane oxygenation
EMA	European Medicines Agency (previously European Agency for the Evaluation of Medicinal Products (EMEA))
FLU-CIN	Influenza Clinical Information Network
FMD	Foot-and-mouth disease
GCSA	UK Government Chief Scientific Adviser
GMC	General Medical Council
GPC	General Practitioners Committee
HPA	Health Protection Agency
HPS	Health Protection Scotland
ICU	Intensive care unit (see also ITU)
ILI	Influenza-like illness
ITU	Intensive treatment unit (see also ICU)
JCVI	Joint Committee on Vaccination and Immunisation
LRF	Local Resilience Forum/a

MISC32	Ministerial Committee on Pandemic Influenza Planning
NCC	News Coordination Centre
NMC	Nursing and Midwifery Council
NPFS	National Pandemic Flu Service
NSC (THRC)	National Security Council (Threats, Hazards, Resilience and Contingencies)
PCT	Primary care trust
PICO	Pandemic Influenza Clinical and Operational Advisory Group
PICO-CSG	Clinical Sub-group of PICO
RCGP	Royal College of General Practitioners
RCM	Royal College of Midwives
RCOG	Royal College of Obstetricians and Gynaecologists
RHH	Respiratory health and hand hygiene
SAC	Scientific Advisory Committee
SAG	Scientific Advisory Group
SAGE	Scientific Advisory Group for Emergencies
SECC Flu	Scottish Emergencies Coordinating Committee's Sub-group for Pandemic Influenza
SFCCCG	Swine Flu Critical Care Clinical Group
SFE	Statement of Financial Entitlements
SHA	Strategic health authority
SPI	Scientific Pandemic Influenza Advisory Committee
SPI-B&C	Behaviour and Communication sub-group of SPI
SPI-CC	Clinical Countermeasures sub-group of the SPI
SPI-M	Modelling sub-group of the SPI
SPI-M-O	Modelling and Operational sub-group of the SPI
URN	Unique reference number
WAG	Welsh Assembly Government
WHO	World Health Organization

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Apendix 1

Week number and corresponding week ending data

Apendix 1: Week number and corresponding week ending data

Table A1: week number and corresponding week ending data

Week number	Corresponding date and year	Week number	Corresponding date and year
Week 28	week ending 12 July 2009	Week 45	week ending 8 Nov 2009
Week 29	week ending 19 July 2009	Week 46	week ending 15 Nov 2009
Week 30	week ending 26 July 2009	Week 47	week ending 22 Nov 2009
Week 31	week ending 2 Aug 2009	Week 48	week ending 29 Nov 2009
Week 32	week ending 9 Aug 2009	Week 49	week ending 6 Dec 2009
Week 33	week ending 16 Aug 2009	Week 50	week ending 13 Dec 2009
Week 34	week ending 23 Aug 2009	Week 51	week ending 20 Dec 2009
Week 35	week ending 30 Aug 2009	Week 52	week ending 27 Dec 2009
Week 36	week ending 6 Sept 2009	Week 53	week ending 03 Jan 2010
Week 37	week ending 13 Sept 2009	Week 1	week ending 10 Jan 2010
Week 38	week ending 20 Sept 2009	Week 2	week ending 17 Jan 2010
Week 39	week ending 27 Sept 2009	Week 3	week ending 24 Jan 2010
Week 40	week ending 4 Oct 2009	Week 4	week ending 31 Jan 2010
Week 41	week ending 11 Oct 2009	Week 5	week ending 7 Feb 2010
Week 42	week ending 18 Oct 2009	Week 6	week ending 14 Feb 2010
Week 43	week ending 25 Oct 2009	Week 7	week ending 21 Feb 2010
Week 44	week ending 1 Nov 2009	Week 8	week ending 31 Mar 2010