Influenza A(H1N1)pdm09 vaccination policies and coverage in Europe

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Citation style for this article:
Mereckiene J, Cotter S, Weber JT, Nicoll A, D'Ancona F, Lopalco PL, Johansen K, Wasley AM, Jorgensen P, Lévy-Bruhl D, Giambi C, Stefanoff P, Dematte L, O'Flanagan D, the VENICE project gatekeepers group. Influenza A(H1N1)pdm09 vaccination policies and coverage in Europe.
Euro Surveill. 2012;17(4):pii=20064. Available online: http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=20064

Article published on 26 January 2012

In August 2010 the Vaccine European New Integrated Collaboration Effort (VENICE) project conducted a survey to collect information on influenza A(H1N1) pdm09 vaccination policies and vaccination coverage in the European Union (EU), Norway and Iceland. Of 29 responding countries, 26 organised national pandemic influenza vaccination and one country had recommendations for vaccination but did not have a specific programme. Of the 27 countries with vaccine recommendations, all recommended it for healthcare workers and pregnant women. Twelve countries recommended vaccine for all ages. Six and three countries had recommendations for specific age groups in children and in adults, countries for specific adult age groups. Most countries recommended vaccine for those in new risk groups identified early in the pandemic such as morbid obese and people with neurologic diseases. Two thirds of countries started their vaccination campaigns within a four week period after week 40/2009. The reported vaccination coverage varied between countries from 0.4% to 59% for the entire population (22 countries); 3% to 68% for healthcare workers (13 countries); 0% to 58% for pregnant women (12 countries); 0.2% to 74% for children (12 countries). Most countries identified similar target groups for pandemic vaccine, but substantial variability in vaccination coverage was seen. The recommendations were in accordance with policy advice from the EU Health Security Committee and the World Health Organization.

Introduction

In late April 2009, the World Health Organization (WHO) received reports of sustained person-to-person transmission of infection with a previously unreported influenza A(H1N1) virus in Mexico and the United States. The virus quickly spread to multiple countries in Europe, the Americas and the Far East. After transmission had been established on more than one continent, the WHO declared a pandemic on 11 June 2009 [1].

Based on the epidemiologic characterisation of the groups most affected during the early phase of the pandemic, WHO's Strategic Advisory Group of Experts (SAGE) and the European Union (EU) Health Security Committee (HSC) [2] issued similar recommendations on target groups for pandemic vaccination.

The WHO SAGE on immunisation recommended that 'All countries should immunise their healthcare workers as a first priority to protect the essential health infrastructure.' The committee also suggested that countries should consider prioritising vaccination of other groups in the following order, but noted that countries needed to determine their order of priority based on country-specific conditions: (i) pregnant women, (ii) individuals aged › six months with one of several chronic medical conditions, including asthma and morbid obesity (body mass index (BMI) ≥40 kg/m^2), (iii) healthy young adults (aged ›15 years and ‹49 years), (iv) healthy children, (v) healthy adults aged ›49 years and ‹65 years, (vi) healthy adults aged 65 years and older [3].

The representatives of the EU Members States (MS) in the HSC with the scientific support of the European Centre for Disease Prevention and Control (ECDC) and the European Medicines Agency (EMA) recommended three priority groups to be vaccinated first, if limited amounts of vaccine were available: (i) all persons ≥ six months with underlying chronic conditions increasing

the risk for severe disease, starting with the ones who have a severe underlying condition (e.g. severe asthma, unstable coronary heart disease, uncompensated heart failure), (ii) pregnant women, and (iii) healthcare workers (HCWs). After the priority groups had been vaccinated, the vaccination could continue according to national recommendations [4-6].

The HSC priority policy focussed on vaccination of priority groups. Based on estimates of the proportion of those under 65 years of age in risk groups (8.5%) and estimation of the proportion of the population in HCWs (3%) it was estimated that approximately 12% of the population should be vaccinated [7,8].

Prior to the 2009 pandemic almost all EU/European Economic Area (EEA) countries had included pandemic vaccine as a component of their plans for mitigation or control [9]. Rapid central authorisation had been planned for using a 'mock-up vaccine' strategy [10] and following vaccine authorisation by EMA and the Commission (or by corresponding national regulatory bodies) vaccination plans were implemented across the majority of countries.

To document the policies and enactment of the pandemic vaccination, ECDC requested the Vaccine European New Integrated Collaboration Effort (VENICE) consortium to undertake a survey among MS with the aim of describing the policies, practises and performance of the national programmes. The specific objectives of this paper are to describe the vaccination policies including specific groups targeted for vaccination and to present obtained estimated vaccination coverage rates of pandemic vaccine among EU/EEA countries during the 2009 pandemic.

Methods

The VENICE project undertook a web-based survey covering 27 EU MS and two EEA countries (Norway and Iceland) (hereafter- VENICE participating countries). The WHO Regional Office for Europe was invited to collaborate in order to avoid redundant surveys in the EU. All WHO European region countries were invited to participate in the one survey. A joint report from WHO and VENICE will be presented separately on these compiled data. This paper includes data from the EU MS, Norway and Iceland only.

The survey was conducted in August 2010. The questionnaire was placed on the VENICE website platform and was available for all assigned representatives from each VENICE participating country [11]. Non-responders were followed up with two reminders in early September. Data were gathered through national 'gatekeepers' (nominated vaccination experts with delegated responsibility to enact VENICE surveys for their country). Gatekeepers were particularly asked to collaborate with the national members of the EU HSC, influenza section in order to validate survey responses. Data were collected using a standardised questionnaire seeking information on population groups recommended for pandemic vaccine (age groups, chronic diseases and underlying conditions, occupation or other social groups), programme funding, logistics associated with the national programmes (doses of vaccine purchased and distributed in each country), vaccination coverage rates achieved and factors influencing vaccination coverage. Countries were also asked to report the order of priority in which target groups were being offered vaccination. Due to different dates of vaccination initiation in MS, arbitrary country-specific phases of the 2009 pandemic were created: early, middle and late phase, not reflecting identical calendar time periods. This paper describes part of collected data on vaccination policy, recommendations and vaccination coverage results. We have also included data obtained from ECDC summarising the vaccines available for use in Europe during the pandemic as background information.

Results

Vaccination policy and recommendations

All 29 EU/EEA countries participating in the VENICE project responded to the survey (data from the United Kingdom (UK) were provided only for England). Twenty-six countries reported implementing pandemic vaccination programmes. Latvia and Poland reported they did not have such programmes and Bulgaria reported it had vaccination recommendations but did not enact its programme because vaccine was not available until after the pandemic subsided. Twenty-five countries published an official document (policy, guidelines) on vaccination recommendations for their population. Nearly all countries with programmes had the same policy across the country, only Sweden reported having different regional strategies.

Vaccines used within the European Union/ European Economic Area countries

Vaccines available to EU/EEA MS included eight vaccines, three of which were centrally authorised by the European Commission (Focetria, Pandemrix, Celvapan) with additional (n=5) vaccines receiving national authorisation. All vaccines (all inactivated) were based on the initial isolate of the new pandemic virus strain, A/California/7/2009(H1N1). An overview of the vaccines used is detailed in Table 1 and describes the vaccine product description, the culture medium, haemagglutinin content, adjuvant emulsion and number of doses, as recommended in December 2009.

Age groups

Twelve countries recommended vaccine for individuals of all ages. Six countries had recommendations for varying age groups in children, and three countries recommended pandemic vaccine to varying adult age groups (Table 2).

Established and new risk groups

Chronic diseases and conditions (Table 2) were considered as indications for pandemic vaccine. All countries

with recommendations for vaccination with pandemic vaccine (n=27) recommended vaccine for those with chronic respiratory, cardiovascular or renal diseases; 26 countries recommended vaccination of those with neurologic and metabolic disorders; 25 countries recommended pandemic vaccine for those with chronic liver diseases or immunosuppression due to disease or treatment; however only 16 recommended vaccination for individuals with morbid obesity (defined as body mass index (BMI) ≥40 kg/m²).

Pregnant women

All 27 countries recommended vaccine to pregnant women: 25 countries to all pregnant women. Bulgaria and Romania recommended vaccine only for those pregnant women with an additional risk condition. Twelve countries recommended pandemic vaccine at any stage in pregnancy and 14 during either the second or third trimester. Twelve countries also recommended vaccine for postpartum women if not already vaccinated (Table 2).

Occupational groups

All 27 countries recommended HCWs should be offered vaccine (Table 2). Sixteen countries recommended vaccine to all HCWs and 11 to some (those having close contact with patients, or for staff with no contact with patients, but contact with potentially contaminated material e.g. in laboratories).Vaccine was recommended for some other occupational essential service groups: police in 12 countries, military in 11 countries, firemen in nine countries and staff in the educational sector in seven countries. In Luxembourg vaccination was recommended only to educational staff working with very young children.

Other social groups

Twelve countries followed a 'cocooning strategy' recommending vaccination of household contacts of children of six months of age or under (who were too young to be vaccinated) and nine countries recommended vaccination of household contacts of at risk individu-

Table 1

Overview of vaccines against influenza A(H1N1)pdm09 available in the European Union in December 2009

Name, producer	Product description	Culture medium	Haemagglutinin content	Adjuvant emulsion	Number of doses
Celvapan, Baxter	Whole virion, wild-type A/ California/7/2009 (H1N1), inactivated	Vero cell- derived	7.5 µg	None	All › 6 months 2 x 0.5 mL
Pandemrix, GSK	Split-virion, reassortant A/ California/7/2009 (H1N1)-like strain, inactivated, adjuvanted	Egg-derived	3.75 µg (per full dose)	AS03	Adults, adolescents and children ≥ 10 years 1 x 0.5 mL
			1.87 µg (per half dose)		Children 6 months – 9 years 2 x 0.25 mL
Focetria, Novartis	Surface-antigens (haemagglutinin and neuraminidase), reassortant, A/ California/7/2009 (H1N1)-like strain, inactivated, adjuvanted	Egg-derived	7.5 µg	MF59C.1	Adults, adolescents and children ≥ 9 years 1 x 0.5 mL
					Children 6 months – 8 years 2 x 0.5 mL
Fluval P, Omnivest	Whole virion, reassortant A/ California/7/2009 (H1N1)-like strain, inactivated, adjuvanted	Egg-derived	6 µg (per full dose)	Aluminium phosphate	Adults and adolescents › 12 years 1 x 0.5 mL
			3 µg (per half dose)		Children 12 months –12 years 1 x 0.25 mL
Panenza, Sanofi Pasteur	Split-virion, reassortant A/ California/7/2009 (H1N1)-like strain, inactivated	Egg-derived	15 µg (per full dose)	None	Adults, adolescents and children › 8 years 1 x 0.5 mL Elderly › 60 years and children 3 – 8 years 2 x 0.5 mL
			7.5 µg (per half dose)		Children 6 – 35 months 2 x 0.25 mL
Celtura, Novartis	Surface-antigens (haemagglutinin and neuraminidase), reassortant, A/ California/7/2009 (H1N1)-like strain, inactivated, adjuvanted	MDCK cell-derived	3.75 µg	MF59C.1	Adults 18 – 40 years, children 3 – 17 years 1 x 0.25 mL
					Adults › 40 years 2 x 0.25 mL
PanvaxH1N1, CSL	Split-virion, reassortant A/ California/7/2009 (H1N1)-like strain, inactivated	Egg-derived	15 µg	None	Adults, adolescents and children › 9 years 1 x 0.5 mL
CANTGRIP, Cantacuzino	Split-virion, reassortant A/ California/7/2009 (H1N1)-like strain, inactivated	Egg-derived	15 µg	None	Adults ≥ 18 years 1 x 0.5 mL

Number of doses is as recommended in December 2009 but in some countries the number of doses and dosage changed over time.
Source: European Centre for Disease Prevention and Control (ECDC) data.

als. Vaccination was also recommended for residents of long-term care facilities in 14 countries (Table 2).

Implementation of vaccination - prioritisation by groups and entire population

Of the 26 countries with pandemic vaccination programmes that reported when they started and finished (not all reported finish date) immunisation, the first began in week 40 of 2009 (week starting 28 September 2009) and by week 44 (end of week 1 November 2009) more than two thirds of the countries had commenced their programmes. However there was a long 'tail' with some countries not able to start until near the end of 2009 (Figure).

Of the 27 countries with vaccination recommendations, vaccine was reported to be prioritised within recommended groups in 22 countries: Austria, Belgium, Cyprus, Czech Republic, Denmark, England, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, Norway, Portugal, Romania, Slovakia, Slovenia and Sweden. In contrast Bulgaria, Estonia, Lithuania, the Netherlands and Spain did not report prioritising any group.

Among the 22 countries that prioritised there was considerable standardisation (Table 3). In the early phase of the pandemic vaccination programme, most countries prioritised HCWs, individuals with chronic diseases or underlying conditions and pregnant women. Some countries also implemented a 'cocooning strategy' approach during this phase. In the middle phase, nine countries prioritised vaccination of the population according to age groups; by the late phase vaccination was offered to the entire population in seven countries.

Vaccination monitoring and coverage

Twenty-two countries provided population-wide data on pandemic influenza vaccination coverage (range 0.4% to 59%). The highest reported population vaccination coverage was reached in the Netherlands and the Nordic countries (Denmark did not report total population coverage) (range 30% to 59%).

Table 2

Population groups recommended for pandemic influenza vaccine in the European Union Member States and European Economic Area countries that had vaccination recommendations during the 2009 pandemic, influenza A(H1N1)pdm09 vaccination survey, August 2010 (n=27 countries)

Population groups	Number of countries
Age[a]	
Children	
All (≥6 months – <18 years)	13
Some age groups[b]	6
Only in risk groups/underlying conditions	7
Adults	
All (≥18 years)	13
Some age groups[c]	3
Only in risk groups/underlying conditions	10
All ages	
All age groups	12
Chronic diseases and underlying conditions	
Respiratory	27
Cardiovascular	27
Renal	27
Neurological /neuromuscular	26
Metabolic (including diabetes)	26
Hepatic	25
Immunosuppression due to disease or treatment	25
Any condition compromising respiratory function	21
Hematologic	18
Haemoglobinophathies	16
Morbid obesity (Body Mass Index >40 kg/m²)	16
Pregnant women	27
All	25
Only with additional risk condition	2
Any trimester[a]	12
Either second or third trimester	14
Postpartum if not vaccinated	12
Occupations	
Healthcare	27
Police	12
Military	11
Firefighters	9
Border control	7
Educational	7
Public transport	6
Energy	7
Finance /banking	3
Other populations	
Close contacts (cocooning strategy)[d] of:	
Infants ≤6 months of age	12
Individuals in risk groups	9
Residents of long term care facilities	14

[a] One country did not answer this question.

[b] Some children (n=6): >1 year–2 years (Estonia); 6 months–5 years (England); 6 months–4 years (Netherlands); 12 months–18 years (Hungary); 6 months–12 years (Portugal); >16–17 years (Romania).

[c] Some adults: >60 years (Netherlands); 18–27 years (Italy); ≥65 years (England).

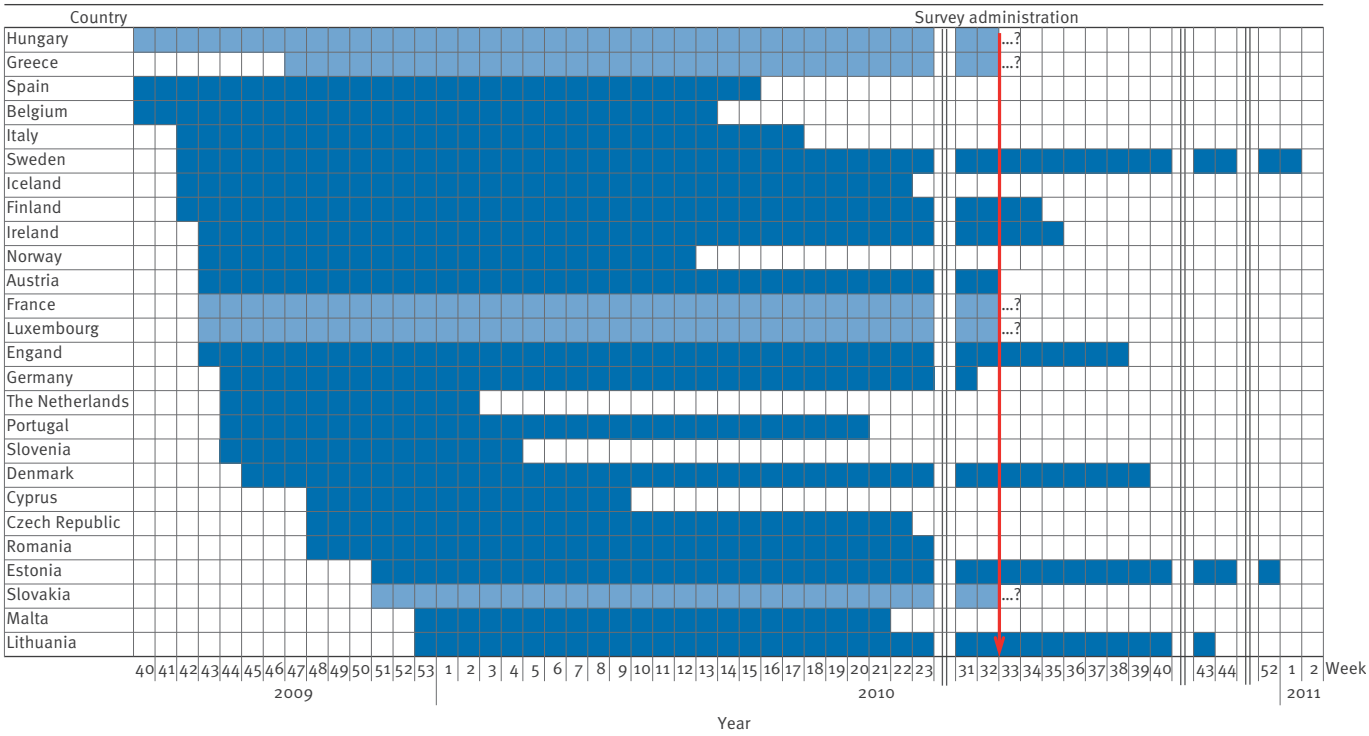
[d] Definition and rationale for "cocooning": Infants ≤6 months of age having little if any immunity to influenza if their mothers were not vaccinated during pregnancy are at higher risk of influenza-related complications. To ensure infant protection, immediate household contacts (representing its cocoon) should be vaccinated against influenza A(H1N1)pdm09 so they will not transmit the virus to the infant. The same concept applies to individuals with some chronic diseases (e.g., patients with hematopoietic stem cell transplants) since the immune response to the vaccine may be inadequate, vaccination of contacts (household members, healthcare workers, and other individuals) is recommended.

Vaccination coverage data for HCWs were available in 13 countries (range 3% to 68%), with the highest coverage reported in the Netherlands, Romania and Hungary (range 50% to 68%).

Vaccination coverage in pregnant women and children (age groups targeted among children varied by country) was provided by 12 countries (range 0% to 58% and 0.2% to 74% respectively). The highest vaccination coverage among pregnant women was reported by the Netherlands and Ireland. The highest coverage among children among those providing data was achieved in the Netherlands, Finland and Norway (Table 4).

Figure

Vaccination programmes for pandemic influenza vaccine in the European Union Member States and European Economic Area countries that organised national pandemic influenza vaccination during the 2009 pandemic, influenza A(H1N1) pdm09 vaccination survey, August 2010 (n=26 countries)



The figure covers the period from 28 Sep 2009 to 9 Jan 2011.
Due to lack of space in the figure there are breaks between weeks in the year 2010.

Table 3

Pandemic vaccination of priority groups and entire population in the European Union Member States and European Economic Area countries that prioritised vaccination within recommended groups during the 2009 pandemic, influenza A(H1N1)pdm09 vaccination survey, August 2010 (n=22 countries)

	Initial priority (Number of countries)	Middle priority (Number of countries)	Late priority (Number of countries)	Total (Number of countries)
Healthcare workers	21	1	0	**22**
Chronic diseases and underlying conditions	14	7	1	**22**
Pregnant women	14	7	0	**21**
Cocooning strategy	5	4	1	**10**
Age groups	2	9	2	**13**
Entire population	1[a]	3	7	**11**

[a] Vaccination was recommended to priority groups, but nobody was excluded if individuals wanted to be vaccinated.

Data on vaccination coverage among persons ≥ six months with chronic diseases and underlying conditions (risk groups varied between countries) were provided by nine countries (range 8% to 72%) with the highest coverage in the Netherlands and Ireland.

Twenty-four of the 26 EU/EEA countries with pandemic vaccination programmes measured pandemic vaccination coverage using administrative methods. Three of these countries (France, Germany and Ireland) also used surveys to estimate vaccination coverage. Although some countries were unable to provide coverage data at the time of the survey and reported that they may be able to report it at a future date.

Potential factors influencing vaccination coverage

Countries reported that a number of public perception factors may have negatively influenced vaccination coverage rates. These included varying levels of

Table 4

Pandemic vaccination coverage among specific groups of population by countries in European Union and European Economic Area during the 2009 pandemic, influenza A(H1N1)pdm09 vaccination survey, August 2010 (n=22 countries)

	Vaccination coverage (%)				
Countries	Overall[a] (n=22)	≥ 6 months of age with chronic diseases and underlying conditions (n=9)	Pregnant women[b] (n=12)	Children[c] (n=12)	Healthcare workers[d] (n=13)
Austria	3	NA	NA	NA	NA
Cyprus	3	NA	NA	NA	NA
Czech Republic	0.6	NA	0	NA	7
Denmark	NA	20	NA	NA	NA
England	NA	38	15	24	40
Estonia	3	21	5	NA	21
Finland	50	NA	NA	74	NA
France	8	NA	23	10	NA
Germany[e]	8	12	9	NA	16
Greece	3	NA	NA	NA	NA
Hungary	27	NA	9	NA	68
Iceland	46	NA	NA	45	NA
Ireland	23	48	32	46	31
Italy	4	13	12	0.3	15
Luxembourg	6	8	NA	7	NA
Malta	23	NA	NA	NA	40
Netherlands	30	72	58	74	50
Norway	45	NA	NA	55	NA
Portugal	6	NA	18	15	35
Romania	9	NA	NA	NA	51
Spain	27	24	9	NA	12
Sweden[f]	59	NA	NA	NA	NA
Slovenia	5	NA	1	1	NA
Slovakia	0.4	NA	NA	0.2	3

[a] Some countries recommended pandemic vaccine for some population groups but calculated overall vaccination coverage.

[b] Pregnant women: all countries that provided vaccination coverage recommended vaccination to all pregnant women (with or without risk indication).

[c] Groups for which vaccination coverage were measured: France, Iceland, Italy, Norway and Slovenia (n=5), ≥6months–<18years of age; England, ≥6 months–<5 years of age; Finland, ≤15 years of age; Ireland, >6months–<15years or age; Luxembourg, at risk; Netherlands, ≥6 months–4years of age; Portugal, ≥6 months–12 years of age.

[d] Healthcare workers: Czech Republic, England, Malta, Netherlands, Portugal (n=5) recommended pandemic vaccine to only healthcare workers with close contact with patients; Estonia recommended for healthcare workers with close contact with patient and with no contact with patients, but contact with potentially contaminated material; Hungary, Malta, Romania, Spain, Sweden and Slovakia (n=6) recommended pandemic vaccine to all healthcare workers.

[e] Data for age groups ≥14 years.

[f] In Sweden - more recent data reported higher vaccination coverage from four regions, suggesting that vaccination coverage may have been higher than reported at time of survey. The vaccination coverage was on average 67 % for children and adolescents under the age of 20 and 51% for adults in four regions (with immunisation registries) in Sweden. These four regions have around 5.3 million inhabitants (the whole of Sweden is 9.1 million), which corresponds roughly to 57 % of the Swedish population [12].

NA: Data not available or not provided for this specific population group at the time of survey.

Vaccination coverage figures in this table were rounded.

concern about vaccine safety (n=13), confidence in the need for the vaccine (n=23), concerns about thiomersal (n=12), or adjuvant in the vaccine (n=18), accelerated licensing process (n=16). Comparison with VENICE surveys for seasonal influenza showed that on the whole countries where there was usually little use of seasonal influenza vaccines vaccinated fewer people with pandemic vaccine and their pandemic vaccine programmes started later. However not all countries that used seasonal influenza vaccines routinely for risk groups immunised many people in the pandemic and there were a number of countries that experienced particular difficulties which usually immunised substantial proportions of their older population [13].

Discussion

These results demonstrate that European countries' recommendations and implementation of their pandemic vaccination programmes broadly followed both the EU/WHO recommendations issued during the summer of 2009 [3,5]. A large majority of countries recommended vaccination of those ≥ six months of age with chronic conditions, pregnant women and HCWs. What differences there were between the EU and SAGE positions probably reflected that the former represented a consensus between Ministries of Health, and therefore was a pragmatic choice based partially on the amounts of vaccines countries had ordered. In contrast the SAGE recommendation was a less constrained expert opinion. A number of EU countries which had ordered larger amounts of vaccine went on beyond the HSC recommendation to other population groups, age-groups, or entire populations. This was done with the stepwise approach as recommended by the WHO [3].

As the pandemic spread, a number of new clinical risk group categories emerged, and recommendations for vaccination were adjusted by a number of countries. However, early in the pandemic, severe disease was reported among this group and approximately half the countries then included people with morbid obesity in their recommended groups [14]. Subsequent published studies have reported morbid obesity to be an independent risk factor for severe influenza associated with increased odds of death [15]. Pregnant women were another group added to those recommended for vaccination during the pandemic prompted by American evidence of a severe influenza among pregnant and postpartum women early in the pandemic [16]. An additional benefit of vaccination of the mother during pregnancy is that it directly and indirectly protects infants during their vulnerable first months of life when they cannot be immunised [17-21]. Countries recommending vaccination of pregnant women increased from 10 in 2008-09 to all 27 countries in the pandemic (two countries recommended vaccination only for pregnant women with other established risk conditions) [13].

Children posed a difficulty for policy makers. At high risk of infection, they had the highest hospitalisation and age-specific attack rates. Some children (e.g. less than two years of age or with chronic disease) were at particular risk of severe complications. Children spread influenza easily, facilitated by poorer respiratory etiquette and close contact with each other and family members [22,23]. Additionally, they excrete the virus longer than adults [24]. Despite the fact that childhood vaccination was not recommended by the HSC, 19 MS recommended pandemic vaccination for children (Table 1) due to observed highest transmission of influenza A(H1N1)pdm09 virus among schoolchildren [4]. Some countries focussed on vaccinating the vulnerable very young children in particular [4,24]. In the previous seasonal VENICE survey conducted in 2008 only six countries recommended vaccine for children but in the pandemic 19 countries recommended this: 13 as part of the overall population, and six for specific age groups (age groups varied between countries) [13,25,26].

All countries with vaccination programmes recommended vaccinating HCWs with the same rationale as in any influenza season. Most countries recommended vaccinating all HCWs, but some only for staff with patient contact. It was also considered that protecting HCWs at risk of infection during the course of their work was important to maintain morale and defend essential health services during any influenza season [27-30]. This was particularly so during the pandemic when demand on health services was in places intense [31,32].

Many countries reported that the fact that the pandemic was less severe than anticipated in their planning proved to be a mixed blessing. The case for vaccination outside the risk groups was weakened in the view of the public and professionals who sometimes felt they had been promised something worse [33]. The fact that the pandemic severity could worsen at any point was true but not persuasive [34]. For example it meant that recommendations to vaccinate individuals working in essential services became irrelevant outside the health sector. European countries here showed pragmatism since although more than a third of the countries had recommendations to vaccinate essential service staff (11 and 12 countries recommended vaccination of the military and police respectively) most did not do so except as part of whole population policies [4].

A particular problem is how to measure success. It is tempting but misleading to use whole population coverage (Table 3) since a minority of countries aimed to vaccinate the entire population. Countries like the Netherlands, Ireland and England, which adopted a risk group approach, may have done equally well despite lower population coverage. The problem was that the vaccine strategies, protecting the vulnerable versus reducing transmission, were not stated explicitly by the MS. In comparison to presented European data, the estimated population coverage for the United States was 27% with a non-adjuvanted pandemic vaccine and 41% in Canada, with mostly adjuvanted vaccines [35,36]. This is lower than in Nordic countries and the

Netherlands, similar to Spain and Hungary and higher than in the remaining EU/EEA countries [37]. However this comparison should be interpreted with caution as different methods for vaccination coverage measurement were used.

The lack of efficient vaccination coverage assessment mechanisms that allowed measuring vaccination coverage in risk groups during the course of the pandemic prevented MS in accurate monitoring of these interventions. In that sense the systems in the United States were superior as they enabled the monitoring of concerns and problems with vaccination coverage and report these publicly and quickly [38]. No EU country produced such data in real time through some monitored attitudes during the pandemic [39]. Reliability of reported vaccination coverage data also depend on methods used to measure vaccination coverage data. All countries used administrative data and some also used surveys. However, administrative methods used varied between countries limiting the comparability of presently collected data. Comparison of vaccine coverage may be misleading also when different sources for numerators and denominators are used among countries. Comparisons are also difficult due to the different starting date of indication for different target groups. Population-based surveys are valuable tools to assess vaccination coverage rapidly and to obtain additional information such as reasons for vaccination or non-vaccination without causing additional administrative burden to the healthcare system. Additionally they provide an alternative method for validating data obtained from official monitoring sources. However, only three countries used this methodology to augment their administrative methods.

Some new vaccines were more immunogenic than anticipated so that for most vaccines only a single dose was required [40]. Also many older people possessed some immunity from exposure to a similar virus that had circulated before the 1960s [4,41]. However, the mild nature of the pandemic meant that demand and acceptance was less than expected in some countries and this was further complicated by allegations of excessive influence of pharmaceutical companies in policy making [42] and concerns about the safety of the vaccine.

This survey identified similarity across countries in groups most commonly recommended and prioritised for pandemic vaccine as well as marked variability in vaccination coverage rates. Multiple reasons for these discrepancies could be identified, related to the complexity of the communications, public perception and vaccine availability. The results from this survey also demonstrate that countries responded to and changed vaccination policy and recommendations in response to the pandemic, advice from expert groups and the changing epidemiology of the disease.

Based on the results of this survey more work is needed to see how recommendations (at national or international level) can be effectively translated into higher vaccination coverage.

Furthermore in order to improve influenza vaccination coverage countries have to strive to strengthen and/or implement the influenza vaccination coverage monitoring systems in place for most common population groups for whom vaccination is recommended (by age, chronic diseases, occupations including HCWs, pregnant women). In order to make comparison of vaccination coverage at EU/EEA level annual population based surveys conducted using the same or similar methodology may be useful [43,44].

Acknowledgments

The VENICE Project would like to take this opportunity to thank all the gatekeepers, contact points, European Commission C3 Section Members, Influenza Section Health Security Members, members of the work packages, WHO/ECDC for their contributions to this publication. The time generously provided by each person is greatly appreciated.

This study was conducted within the European Centre for Disease Prevention and Control (ECDC) funded Vaccine European New Integrated Collaboration Effort (VENICE) 2 project.

List of Vaccine European New Integrated Collaboration Effort (VENICE) project gatekeepers

Austria - Jean Paul Klein; Belgium - Pierre Van Damme, Martine Sabbe; Bulgaria-Mira Kojouharova; Czech Republic - Bohumir Kriz; Cyprus - Chrystalla Hadjianastassiou, Soteroulla Soteriou; Denmark- Steffen Glismann; Estonia-Natalia Kerbo; Finland- Tuija Leino; France – Daniel Levy-Bruhl, Isabelle Bonmarin; Germany-Sabine Reiter; Greece-Theodora Stavrou; Hungary- Zsuzsanna Molnàr; Iceland- Thorolfur Gudnason; Ireland –Suzanne Cotter; Italy-Caterina Rizzo; Latvia-Jurijs Perevoscikovs; Lithuania-Egle Savckiene; Luxembourg- Berthet Francoise; Malta-Tanya Melillo; The Netherlands- Bianca Snijders, Hester de Melker; Norway- Berit Feiring; Poland- Pawel Stefanoff; Portugal - Paula Valente, Teresa Fernandes; Romania- Adriana Pistol, Mircea Ioan Popa, Rodica Popescu; Slovakia - Helena Hudecova, Jan Mikas; Slovenia-Marta Grgic Vitek; Spain-Josefa Masa Calles, Isabel Pachon del Amo; Sweden - Annika Linde; United Kingdom -Richard Pebody..

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