

Contents lists available at [ScienceDirect](#)

Vaccine

journal homepage: www.elsevier.com/locate/vaccine

Impact of live attenuated influenza vaccination programme for healthy children in Northern Ireland: A comparison of seven influenza seasons, 2010/11–2016/17

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ARTICLE INFO

Article history:

Received 8 August 2017

Received in revised form 16 November 2017

Accepted 1 December 2017

Available online xxx

Keywords:

Influenza

Vaccination

Childhood vaccination

Live attenuated influenza vaccination

Epidemiology

ABSTRACT

Seasonal influenza vaccination for healthy children was introduced in Northern Ireland in the 2013/14 flu season, with an initial pilot year involving two specific cohorts, followed by rollout to all children aged 4–11 years in subsequent seasons. This study aimed to examine the impact of that programme on the burden of flu in primary care over the study period 2010/11–2016/17.

Two routine indicators were used to measure impact – GP in-hour consultations and out-of-hour calls for influenza and influenza-like-illness (ILI). Analysis was conducted overall and stratified by age; rates in children under 14 years of age to measure direct impact and rates in individuals 14 years and over to measure indirect impact. Seven influenza seasons were included, three pre-programme seasons (2010/11–2012/13: phase 0), one pilot season (2013/14: phase 1), and three post-programme seasons (2014/15–2016/17: phase 2).

High uptake of vaccination was observed from the programme introduction, with consistent uptake of over 50% in pre-school age groups and over 75% in primary school age groups. Statistically significant reductions were found in GP in-hours consultations and in out-of-hour calls in phase 2 compared to phase 0, both overall (GP in-hours RR 0.61, 95% CI 0.38–0.98, $p = .040$; out-of-hours RR 0.51, 95% CI 0.27–0.97, $p = .041$) and in the under 14 years group (GP in-hours RR 0.38, 95% CI 0.19–0.75, $p = .006$; out-of-hours RR 0.39, 95% CI 0.19–0.83, $p = .014$).

Our results suggest that there have been reductions in the burden of flu in primary care settings overall and in children aged under 14 years in the seasons since the introduction of healthy children influenza vaccination. Further seasons should be added to subsequent analyses to strengthen this evidence.

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1. Background

Seasonal influenza viruses pose a constant public health threat with significant risk of morbidity and mortality globally. Rates of influenza infection and associated complications are highest in children and the elderly population, with associated high hospitalisation rates in these groups [1]. Evidence also shows that seasonal influenza infections in children have a substantial economic burden, including lost productivity due to working days lost [2]. Annual seasonal influenza vaccination is recognized as the best protection against influenza transmission and infection.

Northern Ireland (NI) has had a programme of targeted influenza vaccination in selected populations for a number of years. Similar to other European countries, the vaccination programme

has been historically targeted at individuals aged over 65 years, individuals aged under 65 who fall into a clinical risk group for flu, and in more recent years pregnant women [3,4]. Despite these vaccination programmes, there remains a considerable burden of disease due to influenza in the United Kingdom (UK), Ireland and throughout Europe [1].

Research has shown that children play a key role in the transmission of the influenza virus, and disease modelling has found that vaccinating children could reduce the clinical burden of influenza in all age groups [5–7]. Therefore expanding the vaccination programme to include healthy children may reduce the burden of influenza in children, whilst also reducing the transmission to other age groups including high risk groups such as the elderly [7–9].

In 2012 the Joint Committee on Vaccination and Immunisation (JCVI) recommended that a programme of universal vaccination for children aged 2–16 years should be introduced in the United

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Kingdom (UK), with the programme being rolled out over several seasons [10]. A live attenuated intranasal administered influenza vaccination (LAIV) was recommended for use, administered intra-nasally. The roll-out varied by jurisdiction, with England, Wales, Scotland and NI each adopting a different schedule. In the first year of the vaccination programme, the 2013/14 influenza season, children aged two and three years old and children in Primary School year 6 (9–10 year olds) were offered the vaccination in NI. In the second year, the 2014/15 season, this cohort was expanded to include all pre-school children aged two to four years old and all children in Primary School (aged 4–11 years), as it has remained since. Pre-school children receive their vaccine in primary care whilst primary school children receive their vaccine in school.

Despite recommendation and implementation of universal childhood vaccination in a number of countries, it is difficult to assess the impact of national programmes [11–17]. Therefore it is important to measure the impact of the vaccination programme in NI, and to add to the available evidence for universal childhood influenza vaccination. Furthermore the programme of universal childhood vaccination is an expensive task, and the previous UK vaccination programme which targeted over individuals 65 years and clinical risk groups was found to provide good value for money in reducing the burden of flu when the vaccine was well matched to the circulating virus [18]. The significant costs associated with extending the vaccination programme to healthy children provide another reason for measuring and communicating the impact, especially in a time of reduced public funding.

The aim of this study was to determine the impact of the childhood vaccination programme in NI on the burden of influenza in children and adults in primary care.

2. Methods

2.1. Disease indicators

Vaccine impact was measured using data extracted from the Health Protection Public Health Agency (PHA) routine primary care influenza enhanced surveillance system. The PHA obtains data from primary care on a weekly basis throughout the year. These data include the number and rate of primary care consultations for influenza and influenza-like illness (ILI) from 98% of primary care practices (in-hours) in NI (approximately 335 GP practices and 1.9 m population). Also included are the number and rate of primary care out of hours (OOH) centres. This therefore includes information on approximately 1.9 m population (98%) for in-hours care and 100% of the NI population for OOH care. Flu is defined as 'a disabling acute respiratory illness accompanied by severe fever and myalgia' and ILI is defined as 'an acute respiratory illness accompanied by variable fever and myalgia'. The data are collected using specific read codes entered by the GP for the two diagnoses.

2.2. Time period

The period of interest was the four seasonal influenza seasons between 2010 and 2017. The seasonal influenza seasons were defined from epidemiological week 40 to week 20 of the following year. Although the dates of the flu season can vary from year to year, weeks 40–20 were chosen because it is the agreed reporting time period for the European Surveillance System (TESSy) during the influenza surveillance season [19]. Pre and post vaccination programme seasons were categorised into three phases: phase 0, 1, and 2. Phase 0 included the influenza seasons prior to the introduction of the childhood vaccination programme, specifically 2010/11, 2011/12 and 2012/13, with the indicator measurements

combined for these seasons in order to minimise potential confounding related to unmeasured variation between the flu seasons. Phase 1 included the 2013/14 season, the first year of the programme, when two specific age cohorts were initially included in the childhood vaccination programme. Phase 2 was defined as 2014/15, 2015/16, and 2016/17, years 2–4 of the rollout of the healthy childhood vaccination programme (see Table 1). In all of these three seasons all children aged between 2 years and 11 years (end of primary school) were included in the flu vaccination programme. The other groups eligible for the vaccine as part of the national flu programme did not change over this period. Phases 1 and 2 were separated due to the differences in the cohorts invited for vaccination over these seasons. Influenza and ILI rates were extracted between week 40 and week 20 in each season.

2.3. Measurement of impact

Cumulative ILI episode incidence rates for in-hours and OOH per 100,000 population were calculated by summing the number of flu/ILI consultations/calls each week for the influenza season relative to the population at risk and multiplying by 100,000. Cumulative incidence rates were calculated for each phase.

Rates were also stratified according to those under 14 years of age and those over 14 years of age for each phase. These age groups were used due to limited availability of age-specific data for the whole time period. As the majority of children in this age group were included in the healthy childhood vaccinated cohort (aged 2–11) and because flu risk is low in the non-vaccinated children (aged 12–14), we felt that for the purpose of this study incidence rates in those under 14 years of age could be used a proxy for the direct impact of the childhood vaccine programme. Incidence rates in those over 14 years of age were defined as incidence rate indirectly attributable to the programme (indirect impact).

Cumulative incidence rates, both overall and age-specific, were compared between phases by calculating risk ratios with 95% confidence intervals using negative binomial regression. All analyses were done using Stata (StataCorp LP).

3. Results

3.1. Uptake of LAIV

In the first year of the vaccination programme (Phase 1 – 2013/14) the uptake rates were 55.5% in 2–3 year old children and 80.5% in Primary 6 children (Fig. 1 & Table 2), amounting to a total of 46,329 children receiving trivalent LAIV (28,247 and 18,082 in each cohort respectively). In the second, third and fourth year of the programme (Phase 2 – 2014/15–2016/17) quadrivalent LAIV was offered to all pre-school children aged 2–4 years old, and all children in primary school (approximately age 4–11 years old). In 2014/15 these populations included 56,561 and 167,491 children, with a total of 164,171 children vaccinated ($n = 30,746$ and $n = 127,812$ in each cohort respectively) giving uptake rates of 54.5% for pre-school children and 79.7% for primary school children. Similar figures were seen in both subsequent seasons of phase 2 (Fig. 1 & Table 2).

Table 1
Outline of each phase of vaccination programme.

Phase	Programme status
Phase 0	Pre-programme (2010/11–2012/13)
Phase 1	Post programme – Year 1 (2013/14)
Phase 2	Post programme – Year 2–4 (2014/15–2016/17)

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