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Research Article

Co-Administration of PPV23 and Influenza Vaccines in England and Wales: A Study Based on the Royal College of General Practitioners Sentinel Surveillance Network

Abstract

Background: Pneumococcal disease is an infection caused by a bacterium called *Streptococcus pneumoniae* which can lead to life-threatening invasive pneumococcal diseases. In the UK, pneumococcal vaccination is targeted at those most at risk of serious disease: infants, older people and those with risk factors. It has been proposed that PPV23 be co-administered with influenza vaccine during seasonal vaccination to maximize uptake. This study aimed to estimate 1) the UK prevalence of pneumococcal risk co-morbidities 2) corresponding pneumococcal vaccine administration rates 3) rates of vaccination co-administration and 4) frequency of pneumococcal revaccination.

Methods: To gather evidence on current vaccination practice in the UK and to quantify the rates of co-administration of influenza and pneumococcal vaccination, data was collected from general practices in the Royal College of General Practitioners sentinel surveillance network. To estimate the frequency of pneumococcal revaccination, the records of all persons vaccinated from 2010-2012 were examined and persons were counted according to the number of prior vaccine doses received since 2004.

Results: The prevalence rate for COPD was highest amongst the risk groups at 83.56 per 1,000 in 2010 and 79.33 in 2012. The vaccination rate was 6 per 1,000 among risk groups. Patients aged between 65 and 74 years showed the highest rate of vaccination (35 per 1,000), and rates were highest in the immunocompromised and leukemia sufferers. Co-administration of pneumococcal and influenza vaccines increased sharply from 47% in 2011 to 61% in 2012. Among patients vaccinated against pneumococcal diseases, the proportion who had previously received a pneumococcal vaccination increased from 3 to 9 per 1,000 vaccinations from 2010 to 2012.

Conclusion: This study clarifies the current state of pneumococcal vaccination in England and Wales and highlights the need for vaccination coverage rates to be improved in order to prevent more cases of pneumococcal diseases.

Introduction

Pneumococcal disease is an infection caused by a bacterium called *Streptococcus pneumoniae* (pneumococcus) [1], which can lead to life-threatening invasive diseases such as bacterial pneumonia, meningitis and bacteremia, as well as non-invasive diseases [2-4]. Every year, *S. pneumoniae* infections account for approximately 1.6 million deaths worldwide and the incidence of invasive pneumococcal diseases (IPD) reaches 15 per 100,000 person-years [1]. In England and Wales, a recent study carried out by Public Health England (PHE; formerly Health Protection Agency [HPA]) reported on average 8,835 IPD cases annually [5]. *S. pneumoniae* infection secondary to influenza has been observed and highlighted in past influenza epidemics [6]. An influenza infection places individuals at risk of developing bacterial infections, a major complication of influenza which the highest risk in the winter months [7]. Coinfection with *S. pneumoniae* is considered as a predictor of severe outcome and a major cause of death [6-11].

Vaccination is a proven public health strategy one can implement to reduce the burden of IPD [3,12]. In the UK, pneumococcal vaccination is targeted at those most at risk of serious disease: infants, the elderly (≥ 65 years) and those with clinical risk factors. Age-based recommendations state that children should receive the conjugate pneumococcal vaccine (PCV) at 2 months, 4 months and between 12 – 13 months, while older people and at-risk patients receive pneumococcal polysaccharide vaccine (PPV23). At-risk patients, both children and adults, receive differing recommendations dependent on their clinical profiles. The clinical risk groups currently recommended to receive pneumococcal vaccination are presented in Table 1, and revaccination is recommended every 5 years for PPV23 for some groups in the high-risk population [13]. A select number of immunosuppressed patients are also recommended to receive a single dose of PPV23 followed by a single dose of PCV [16,17].

Given the similarity between their target populations, it has been proposed to co-administer PPV23 with influenza vaccine

Table 1: Clinical risk categories.

Clinical Risk category	Examples (decision based on clinical judgement)
Asplenia or dysfunction of the spleen	This includes conditions such as homozygous sickle cell disease and coeliac syndrome that may lead to splenic dysfunction.
Chronic respiratory Disease	This includes chronic obstructive pulmonary disease (COPD), including chronic bronchitis and emphysema; and such conditions as bronchiectasis, cystic fibrosis, interstitial lung fibrosis, pneumoconiosis and bronchopulmonary dysplasia (BPD). Children with respiratory conditions caused by aspiration, or a neuromuscular disease (e.g. cerebral palsy) with a risk of aspiration. Asthma is not an indication, unless continuous or frequently repeated use of systemic steroids (as defined in Immunosuppression below) is needed.
Chronic heart disease (CHD)	This includes those requiring regular medication and/or follow-up for ischaemic heart disease, congenital heart disease, hypertension with cardiac complications, and chronic heart failure.
Chronic kidney disease (CKD)	This includes nephrotic syndrome, chronic renal failure, renal transplantation.
Chronic liver disease (CLD)	This includes cirrhosis, biliary atresia, chronic hepatitis.
Diabetes (requiring insulin or oral hypoglycaemic drugs)	This includes type I diabetes requiring insulin or type II diabetes requiring oral hypoglycaemic drugs. It does not include diabetes that is diet controlled.
Immunosuppression	Due to disease or treatment, including asplenia or splenic dysfunction and HIV infection at all stages. Patients undergoing chemotherapy leading to immunosuppression. Individuals treated with or likely to be treated with systemic steroids for more than a month at a dose equivalent to prednisolone 20mg or more per day (any age), or for children under 20kg, a dose of 1mg/kg/day. Some immunocompromised patients may have a suboptimal immunological response to the vaccine.
Individuals with cochlear implants	It is important that immunisation does not delay the cochlear implantation. Where possible, pneumococcal vaccination should be completed at least 2 weeks prior to surgery to allow a protective immune response to develop. In some cases it will not be possible to complete the course prior to surgery. In this instance, the course should be started at any time prior to or following surgery and completed according to the immunisation schedule.
Individuals with cerebrospinal fluid leaks	This includes leakage of cerebrospinal fluid such as following trauma or major skull surgery.

during the seasonal vaccination program to maximize uptake of the former [6]. Furthermore, evidence suggests clinical benefits exist from concomitantly administered vaccine in terms of an additive preventive effect [2,3], a strategy also recommended by PHE.

It is unclear how many pneumococcal vaccines have been co-administered with the influenza vaccine given PHE's advocacy, nor has the revaccination rate been studied. This lack of data may create difficulties in the assessment of vaccination strategies. To address this gap, a retrospective database analysis was conducted based on the Royal College of General Practitioners (RCGP) sentinel surveillance network. The study's main objectives were to estimate:

- The prevalence in the UK of persons with the various risk co-morbidities for whom pneumococcal vaccine is recommended
- The corresponding pneumococcal vaccine administration rates
- The rates of co-administration of the influenza and pneumococcal vaccines for the combined patient group
- The frequency of pneumococcal revaccination by age group

Material and Methods

Data was collected from general practices in the RCGP sentinel surveillance network, which has been shown to be representative of the national population of England and Wales by age, gender and social deprivation. The practices supplying patient records are broadly representative of England and Wales in terms of practice size, age group and practice prescribing patterns [18]. Rates of influenza vaccine uptake have been shown to be similar to the national equivalent uptake rate [19]. The RCGP database is prepared from a direct extract of electronic patient records generated as part of routine patient management. Relevant diagnostic and intervention information is recorded at the time of consultation and stored as Read codes which are mapped to ICD-9 codes for analysis.

The RCGP database was reviewed based on Read codes which 1) described pneumococcal vaccination or vaccine administration; 2) defined risk conditions for influenza vaccination uptake, published and known as PRIMIS code groups [20]; 3) were selected as applicable to risk conditions, even though the conditions were outside the influenza vaccination recommendations; and 4) described malignant disease (leukemia and related conditions and all other malignant neoplasms). Persons in these groups are very likely to be immune suppressed at least in the active treatment periods.

The first stage of the analysis aimed to estimate the prevalence of persons with risk co-morbidities for consideration of pneumococcal vaccination. Risk groups included malignant neoplasms, asplenia, hemolytic anemia, cystic fibrosis and combined pneumococcal specific risk groups. The prevalence rates of those at risk were calculated in 2010-2012 prior to September 1 in each year.

We then sought to estimate pneumococcal vaccine administration rates in the at-risk populations, defined by the presence of risk co-morbidities reported at least once from 2010-2012. Pneumococcal vaccine codes corresponded either to vaccine or vaccine administration. Vaccine uptake rates of the last 5 years were measured in total population age groups and in persons with risk co-morbidities.

The third stage aimed to quantify the rates of co-administration of influenza and pneumococcal vaccines to inform future analyses of vaccination costs. Vaccination data in each of three years were examined and results were consolidated into three age groups (0-14, 15-64 and 65+).

Lastly we estimated the frequency of pneumococcal revaccination by age. Records of all persons vaccinated in 2010-2012 were examined and persons were counted according to the number of prior vaccine doses received since 2004. The analysis was not conducted separately by risk group (which were not fixed over the study duration). Those

receiving the pneumococcal vaccine from 2004-2012 were grouped by the number of vaccines received. All patients who had more than one vaccine recorded were examined separately and then by age group, to study the interval between vaccinations, with the analysis limited to the interval between the first and second vaccinations.

Results

Population eligible to receive pneumococcal vaccination

The RCGP database in 2010 included a total of 1.08 million

patients, 1.02 million patients in 2011 and 603,000 in 2012. Estimates of the prevalence of persons with risk co-morbidities appropriate for consideration of pneumococcal vaccination are reported in [Table 2](#) which presents the three-year estimates for prevalence per 1,000 population by age and risk group from 2010 to 2012. The prevalence rate for chronic obstructive pulmonary disease (COPD) was highest at 83.56 per 1,000 in 2010, 82.77 in 2011, 79.33 in 2012, followed by diabetes and chronic heart disease (CHD) which showed similar, if slightly increasing, prevalence rates in all three years.

Table 2: Three-year prevalence per 1,000 population by risk group.

		Total	2-17y	18-49y	50-64y	65-74y	75+
Chronic obstructive pulmonary disease (COPD)	2010	83.56	78.85	70.04	84.59	120.4	125.94
	2011	82.77	75.2	68.48	85.01	123	127.9
	2012	79.33	68.34	65.11	82.11	120.08	125.59
Diabetes (requiring insulin or oral hypoglycaemic drugs)	2010	47.75	3.74	16.48	71.35	142.58	162.98
	2011	49.11	3.71	16.91	73.16	144.51	166.68
	2012	55.44	4.44	18.61	79.34	160.03	189.13
Chronic heart disease (CHD)	2010	49.49	2.97	10.52	58.12	143.28	246.23
	2011	49.04	2.99	10.37	56.72	139.49	243.54
	2012	50.09	2.77	10.64	57.91	135.92	243.05
Chronic kidney disease (CKD)	2010	29.59	0.4	2.78	23.8	84.16	195.16
	2011	26.76	0.42	2.72	21.21	73.61	175.17
	2012	50.09	2.77	10.64	57.91	135.92	243.05
Immunocompromised	2010	2.6	0.38	1.52	3.44	6.35	7.59
	2011	26.76	0.42	2.72	21.21	73.61	175.17
	2012	2.31	0.32	1.23	3.14	5.1	7.27
Stroke	2010	8.39	0.07	0.91	7.59	22.64	54.21
	2011	8.53	0.1	0.92	7.42	22.87	54.83
	2012	8.88	0.13	1.08	7.81	22.5	54.79
Liver disease	2010	3.09	0.09	2.31	6.72	6.32	2.59
	2011	3.58	0.12	2.72	7.64	7.07	3.17
	2012	3.58	0.12	2.64	7.84	7.04	3.12
Multiple sclerosis	2010	9.63	1.97	4.22	10.95	21.06	40.99
	2011	9.96	1.92	4.43	11.06	21.18	42.73
	2012	10.27	1.91	4.44	10.87	21.51	44.39
Malignant neoplasms	2010	9.63	1.97	4.22	10.95	21.06	40.99
	2011	1.48	0.2	0.41	1.89	4.41	6.08
	2012	1.53	0.19	0.38	1.91	4.16	6.57
Other neoplasms	2010	20.34	0.16	4.27	27.01	62.23	93.43
	2011	20.67	0.15	4.17	27.36	62.55	94.66
	2012	20.83	0.12	4.35	26.19	63.19	92.07
Asplenia	2010	1.64	0.99	1.43	2.08	2.78	2.04
	2011	1.74	1.01	1.49	2.34	2.92	2.09
	2012	1.82	1.11	1.42	2.62	3.13	2.25
Haemolytic anaemia	2010	1	1.15	1.22	0.57	0.67	0.77
	2011	1.05	1.19	1.32	0.57	0.67	0.8
	2012	1.05	1.21	1.32	0.52	0.71	0.81
Cystic fibrosis	2010	0.09	0.2	0.12	0.01	0.01	0
	2011	0.1	0.22	0.11	0.02	0.01	0
	2012	0.11	0.21	0.14	0.03	0.02	0
Pneumococcal specific (cochlear implant and cerebrospinal fluid leak risk)	2010	0.01	0	0.01	0.02	0.02	0.03
	2011	0.01	0	0.02	0.01	0.02	0.01
	2012	0.01	0	0.02	0.03	0	0.02
Combined pneumococcal specific (CKD, asplenia, cochlear implant and cerebrospinal fluid leak)	2010	31.16	1.39	4.22	25.82	86.59	196.83
	2011	28.43	1.43	4.21	23.47	76.23	176.89
	2012	24.08	1.44	3.5	19.13	62.96	145.73



Pneumococcal vaccine administration rates

Estimates of the pneumococcal vaccine administration rates are presented in Table 3 as the rate per 1,000 population by age group for the general population and by risk group. Using records from 114 practices in 2010, 6,998 (6 per 1,000) were found to have received the vaccine. Patients aged between 65 and 74 years showed the highest rate of vaccination (35 per 1,000), and rates did not differ significantly between males and females. Currently about 8 per 1,000 persons older than 2 years of age receive the pneumococcal vaccine annually.

Rates by risk group were calculated from the previous estimates of the prevalence of patients with risk-comorbidities. For example,

90,111 persons were identified with COPD (prevalence of 88 per 1,000), of whom approximately 1% received the vaccine in 2010. With the exception of the highly specific pneumococcal risk group (cochlear implant and cerebrospinal fluid leak risk), all co-morbidity groups are exclusive, but persons may have several co-morbidities. The risk groups corresponding to chronic kidney disease and the combined pneumococcal specific risk group had rates in 2012 that were two standard errors higher than the 2010 rate (representing a doubling of the vaccination rate from 2010 to 2012).

The number of individuals classified in the risk groups receiving pneumococcal vaccine totaled approximately 5,000 compared with

Table 3: Persons receiving pneumococcal vaccine; rate per 1,000 population by age group.

		Total	2-17y	18-49y	50-64y	65-74y	75+	s/e 2010 Total pop*.
General population	2010	6.49	0.59	1.86	10.56	35.39	5.42	0.96
	2011	7.81	0.61	2.1	12.09	41.47	9.25	
	2012	7.7	0.66	1.97	10.5	40.55	10.84	
Chronic obstructive pulmonary disease (COPD)	2010	13.75	2.79	9.38	28.77	26.46	7	3.308
	2011	15.09	3.39	8.67	28.64	32.65	10.91	
	2012	16.37	2.98	8.05	27.47	39.36	15.03	
Diabetes	2010	24.25	15.69	39.98	39.89	19.06	5.54	4.353
	2011	23.73	18.23	31.08	33.71	22.74	11.28	
	2012	29.56	13.97	30.79	35.88	39.38	15.27	
Chronic heart disease (CHD)	2010	18.53	8.24	15.27	30.62	30.16	6.13	4.288
	2011	21.9	6.97	20.49	34.84	32.92	9.38	
	2012	26.89	3.22	12.23	32.77	41.41	19.11	
Chronic kidney disease (CKD)	2010	16.39	24.39	21.5	33.46	26.87	6.61	5.552
	2011	23.1	12.5	35.4	41.31	36.52	11.39	
	2012	34.92	26.32	41.44	46.98	40.95	28.87	
Immuno-compromised	2010	48.91	25.97	52.92	72.86	46.82	24.67	18.427
	2011	47.13	28.17	63.47	60.65	46.35	18.92	
	2012	53.92	55.56	66.47	76.92	41.67	31.17	
Stroke	2010	17.23	0	27.15	35.62	29.08	5.49	10.419
	2011	47.13	28.17	63.47	60.65	46.35	18.92	
	2012	28.21	0	30.93	41.24	45.63	16.54	
Liver disease	2010	24.59	55.56	16.06	28.55	40.34	0	17.103
	2011	24.7	0	20.13	27.99	31.3	14.55	
	2012	18.97	0	12.69	17.12	40.2	6.06	
Multiple sclerosis	2010	12.71	2.49	8.29	18.86	28.24	4.3	9.75
	2011	19.15	2.72	12.85	26.86	40.23	8.91	
	2012	17.93	0	8.38	18.95	39.51	12.76	
Malignant neoplasms	2010	30.95	23.26	39.41	64.86	26.96	7.59	24.997
	2011	30.44	0	37.84	52.49	40.1	7.59	
	2012	39.13	47.62	29.13	84.51	25.53	22.99	
Other neoplasms	2010	15.68	62.5	8.69	16.75	30.88	6.01	6.698
	2011	23.67	35.71	12.08	27.83	43.52	9.99	
	2012	21.9	76.92	11.97	22.9	35.57	13.53	
Haemolytic anaemia	2010	13.93	12.77	10.12	17.24	47.62	14.29	30.261
	2011	13.1	13.16	9.97	27.52	16.39	14.49	
	2012	23.73	36.76	8.45	17.24	100	46.51	
Cystic fibrosis	2010	58.82	121.95	17.54	0	0	0	96.056
	2011	40.82	23.81	57.69	0	0	0	
	2012	45.45	125	0	0	0	0	
Pneumococcal specific risk (CKD, asplenia, cerebrospinal fluid leak)	2010	17.77	21.13	28.81	34.65	27.47	7.05	5.407
	2011	24.23	18.18	33.78	43.1	37.01	11.87	
	2012	37.82	36.81	57.45	49.6	42.73	29.93	

*Standard error for the 2010 total population.



6,998 total vaccinated patients in the study year. This difference arises because many persons over 65 years were vaccinated without being classified as having a chronic condition. Current rates of vaccination were highest in the immunocompromised and leukemia sufferers.

Co-administration of pneumococcal and influenza vaccines

Estimates of the rates of co-administration of influenza and pneumococcal vaccines by age and gender are presented in [Table 4](#). The number of influenza and pneumococcal vaccines was significantly higher in 2010 than in the two subsequent years as reported in [Table 5](#), owing to the high number of persons receiving pandemic vaccinations. Results were therefore not aggregated for the three years to avoid confounding the data on co-administration. Vaccination data from the years 2011 and 2012 show a total of 148,933 males and 190,656 females vaccinated against flu, some of whom received repeat vaccinations in more than one season. The 5,841 male and 6,366 female pneumococcal vaccinations however are unlikely to include any double counting of persons (excepting those few persons given additional vaccine doses in separate years studied).

The data revealed several gender differences in vaccination rates. Influenza vaccination in children 14 years of age and younger recorded slightly more males than females, whilst in older age groups there were more females vaccinated. In light of the higher prevalence of asthma in male children, higher rates of vaccination against flu are to be expected. The higher rate of vaccination in females aged 15-64 can be explained by the vaccination of pregnant women. The higher number of influenza vaccination among females in the 65 years and older age group results from the increased proportion of females within this age group of the general population.

As shown in [Table 4](#), the proportion of patients receiving co-administration of the pneumococcal and influenza vaccines increased sharply from 47% in 2011 to 61% in 2012 ($p < 0.01$). Combined analysis (2011 and 2012) showed 55% of male and 52% of female recipients who received the pneumococcal vaccine also received the influenza vaccine on the same day. This figure was 35% in the 15 to 64 years old group and 54% in the 65 years and older group.

Revaccination

Following the analysis of records of all persons vaccinated from 2010-2012 and the number of prior vaccine doses received since 2004, estimates of the frequency of pneumococcal revaccination were obtained by age group ([Table 6](#)). Among patients vaccinated against pneumococcal diseases, the proportion previously receiving at least one pneumococcal vaccination increased from 3 to 9 per 1,000 vaccinations in 2012. These figures are unlikely to include any double counting as the numerator accounts only for those patients vaccinated in a specific year; any duplication would be restricted to those patients receiving two doses within a given year.

The proportion of persons having received more than one pneumococcal vaccine increased year by year from 2010 to 2012, although remains below 1% of the total vaccinated population. Using data collected on all persons with more than one vaccination, an analysis was then conducted on the interval between the first and

Table 4: Proportions receiving pneumococcal vaccine co-administered with influenza vaccine (%).

		0-14	15-64	65+	All ages
2010	Males	35.37	58.2	55.44	56.39
	Females	17.14	56.23	51.43	53.07
2011	Males	34.09	54.13	46.2	49.82
	Females	32.14	51.36	43.81	47.20
2012	Males	45.83	65.34	63.38	64.04
	Females	43.48	61.13	60.79	60.76

Table 5: Persons receiving vaccines against influenza and pneumococcus, all ages.

	Males			Females		
	2010	2011	2012	2010	2011	2012
Flu vaccine	107,460	93,402	55,531	130,222	119,809	70,847
Pneumococcal vaccine	3,561	3,647	2,194	3,473	3,996	2,370

Table 6: Distribution of vaccinated population by number of pneumococcal vaccines reported.

	Vaccinated	One previous vaccination	Two previous	Three or more previous	Total previous (per 1,000 vaccinations)
2010	6998	211	9	2	222 (3.1)
2011	7947	327	7	5	339 (4.3)
2012	4643	394	14	1	409 (8.8)

Table 7: Interval between first and second pneumococcal vaccination by age group.

Age	0 days	1-364 days	1-4 years	5-7 years	8-10 years	Total
0-2 years	58	0	0	0	0	58
3-49 years	3	6	5	24	3	41
50-64 years	1	8	10	42	4	65
65 years or older	6	21	54	248	27	356
Total	68	35	69	314	34	520

second vaccinations according to age, presented in [Table 7](#). There were 68 persons receiving both vaccines on the same day, the majority (58) of whom were children less than 2 years of age. Instances where a subsequent primary dose was coded to the first date of administration may explain these occurrences, although it may also be due to other incorrect data entry in some practices. Two-thirds of second doses (348 doses, 67% of total) were given more than 5 years following the first vaccination and only 35 (6.7%) received a second dose within 1-364 days following the first vaccination.

Discussion

Approximately 8 per 1,000 population were given the pneumococcal vaccine each year, whereby population is defined as the RCGP database population. The highest rates were seen in the 65-74 age group, in which approximately 40 per 1,000 individuals were vaccinated, and among risk groups were highest in the immunocompromised and leukemia sufferers.

Rates of co-administration of the influenza and pneumococcal vaccines showed that in adults, just over 50% of pneumococcal vaccines were co-administered with the influenza vaccine, with 38% in vaccinated children. There were small differences in this rate

between sex and age groups attributable to the demographics of the population, prevalence of COPD (higher in males) and routine influenza vaccination of pregnant women.

Two-thirds of persons receiving repeat vaccination received this at the recommended interval of 5 years minimum, but for a significant number (greater than 30%), there may be revaccination within 5 years.

A previous study by Van Hoek et al. [21], used a Department of Health survey on the uptake of 23-valent pneumococcal polysaccharide vaccines using data extracted from 55% of the general practices in England to estimate the prevalence of clinical risk factors in the general population. Rather than using 3-year prevalence rates as in the current study, the authors estimated prevalence rates based on 2008–2009 data alone.

The 3-year prevalence rates of clinical risk factors presented in the current study could be expected to be higher, with discrepancies due in part to certain diseases' changing prevalence rates and data search methodologies of the two studies. Van Hoek et al. used data from ImmForm to record data on uptake of immunization programs and incidence of flu-like illness, covering 60% of the population without assumptions on whether the patient was currently impacted by the disease coded in her records. Diseases such as asplenia may be recorded while not prompting a consultation for most of the patient's life. Similarly, immune suppression is detected from a combination of disease and prescription codes and attempts to detect contemporary immune suppression rather than any period of immune suppression. The database used in the current study did not include these corresponding prescription codes which may have contributed to lower prevalence rates presented in Figure 1.

The current study's higher diabetes prevalence is linked to the inclusions of all diabetics (whether on therapy or diet management) and to its multiyear time horizon. The inclusion of all diabetics reflects an update to influenza vaccination policy which now includes all diabetics. Incidentally pneumococcal vaccination policy has not been

updated to include all diabetics [22], and in our view an alignment of these vaccination policies would be greatly beneficial.

This is the first study we are aware of to investigate the co-administration and revaccination rates of pneumococcal vaccination. Our data may assist decision-makers in developing a strategy to improve the coverage of pneumococcal vaccine in the older population so that more disease cases associated with *S. pneumoniae* infection can be avoided. This is especially true in England and Wales as the study population is representative of the population in terms of age, gender, social deprivation and practice size [18] and the results are in line with an earlier study by the PHE [21].

Several limitations must also be acknowledged. The morbidity of the study population has not been compared to the national population, though this is currently being investigated. Secondly, the analysis of time to revaccination was based on a relatively small sample size considering the recommendation was for a subset of the target population. More data are needed to provide robust estimates. This study included patients with malignant disease as separate risk group, although malignant disease as such is not included in the Green book. Many would argue that these diseases result in impaired immune response whether the patient is receiving an immune suppressant therapy or not. Our results provide additional information on this specific risk group should policy change.

The study provides a clearer picture of the current situation of pneumococcal vaccination in England and Wales, and has presented a vaccination rate that unfortunately remains low. In the at-risk population, the three-year cumulative vaccination rate ranged between 50 and 150 per 1,000 person-years, significantly lower than the uptake rates for influenza vaccination in winter 2012/13, reported to be 73.4% for those aged 65 years and over and 51.3% for those aged six months to under 65 years in one or more clinical at-risk groups [23]. Strategies to improve vaccination coverage rates in the eligible population will lead to the prevention of avoidable disease and should be seen as a priority.

Routine vaccine co-administration could provide such an avenue to higher coverage rates. Assuming administration is carried out by a band 7 advanced nurse in the course of a 10 minute appointment [24], an administration session can cost £15.17, which is almost equivalent to the cost of two pneumococcal vaccines (£8.32; Pneumovax® II, Sanofi Pasteur MSD). More than half of the patients vaccinated against pneumococcal disease within this study received the vaccine co-administered with the influenza vaccine. The current practice of co-administration improves the cost-effectiveness of both programs as it reduces the combined cost of administering the two vaccines by 17.3% compared to separate administration. Improving the co-administration rate would reduce opportunity costs while also leading to higher vaccination coverage rates for the pneumococcal vaccination program. Data from a recent study [25], showed that when co-administration is considered, incremental cost-effectiveness ratio decreased from £14,895 to £8,413 per quality-adjusted life year gained. Future economic evaluations would benefit from taking co-administration into account to ensure the true cost the vaccination program can be accurately estimated.

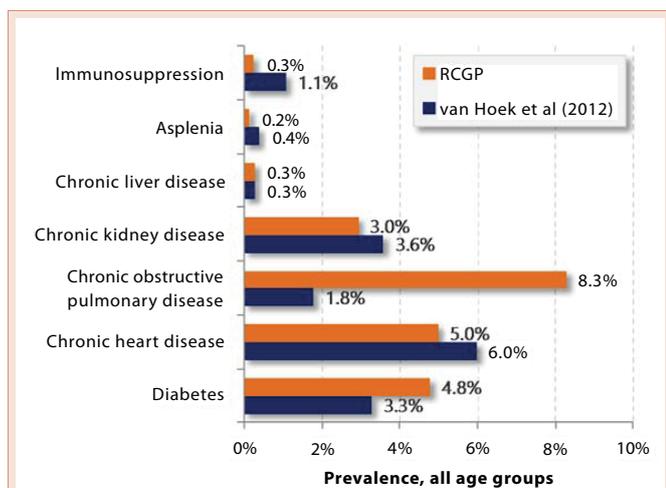


Figure 1: Prevalence of clinical risk factors.



Conclusion

From a sample of over one million patients we presented the prevalence rates for risk groups recommended to receive the pneumococcal vaccine by age group and gender for the three years from 2010 to 2012. In 2010, these prevalence rates ranged from approximately 0.001% in patients with cystic fibrosis to 8.36% for those with COPD.

Rates of pneumococcal vaccine administration were found to be approximately 8 per 1,000 study population, with the highest rates seen in age group 65-74 years and in immunocompromised patients, leukemia sufferers, people with chronic kidney disease and those with cystic fibrosis. Over 50% of pneumococcal vaccines were estimated to be administered at the same time as influenza vaccine, and two-thirds of persons receiving repeat vaccination received it at the recommended interval of 5 years minimum, with some receiving early revaccination.

This study provides a clearer picture of the current situation of pneumococcal vaccination in England and Wales and highlights the need for vaccination coverage rates to be improved in order to prevent more cases of pneumococcal diseases. One possibility includes the use of co-administration of pneumococcal and influenza vaccines as useful tool to support the implementation of the pneumococcal vaccination program.

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Conflicts of Interest

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