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**Early estimates of 2014/15 seasonal influenza vaccine effectiveness in preventing influenza-like illness in general practice using the screening method in France**

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## **Abstract**

The ongoing influenza epidemic is characterized by intense activity with most influenza infections due to the A(H3N2) viruses. Using the screening method, mid-season vaccine effectiveness (VE) in preventing influenza-like illness in primary care was estimated to 32% (95% CI; 23 to 40) among risk groups and was 11% (95% CI; -4 to 23) among the elderly ( $\geq 65$  years). The VE in  $\geq 65$  y was the lowest estimate regarding the 4 previous seasonal influenza epidemics.

**Keywords:** France; influenza-like illness influenza; primary care; vaccine effectiveness .

## **Introduction**

In France, the influenza vaccination strategy targets the following 2 main at risk groups: persons aged 65 y and above and persons below 65 y with certain chronic illness [1].

In the northern hemisphere, the ongoing influenza season was dominated by the A(H3N2) sub-type [2-5]. The A(H3N2) viruses are known to cause more severe illness with potential for complications especially in the elderly and other risk groups targeted for vaccination than A(H1N1)pdm09 and/or B viruses [6, 7]. During the 2014/15 influenza season, a significant proportion of the A(H3N2) viruses characterized antigenically and genetically has demonstrated antigenic drift from the northern hemisphere vaccine component resulting in reduced vaccine effectiveness (VE) [2-5]. Early VE estimates reported from United States (US) [3] United Kingdom (UK) [4] and Canada [5], were low compared with previous seasons when circulating viruses and vaccine viruses were well-matched.

None of these studies provide specific early VE for high-risk population targeted for influenza vaccination. Thus, we estimated here early estimates of influenza VE in the prevention of influenza-like illness (ILI) among target groups in primary care, using the screening method [8].

## **Methods**

### **Study ILI population**

The French *Sentinelles* Network is a surveillance system based on approximately 2% of all French General Practitioners (GPs) [9] combining epidemiological and virological data. ILI cases were reported by sentinel GPs in metropolitan France, as part of routine surveillance using the following definition, “sudden onset of fever  $>39^{\circ}\text{C}$  ( $102^{\circ}\text{F}$ ) with respiratory signs

and myalgia” [10]. The following information was collected for each ILI patient by their GP: date of consultation, age, sex, vaccine status for current seasonal trivalent vaccine, time since vaccination (more or less than 3 weeks) and presence of risk factors (chronic illness). Nasopharyngeal swabs were also collected by GPs in a randomized sample of patients presenting with ILI according to the *Sentinelles* case definition [11].

### **Study period**

Influenza VE against ILI was estimated over five influenza epidemic periods (seasons 2010/11 to 2014/15) identified by the French *Sentinelles* Network (<http://www.sentiweb.fr>) [12]. In order to estimate 2014/15 early VE, the study period ran from week 3 (12<sup>th</sup> to 18<sup>th</sup> January 2015), which was the beginning of the influenza epidemic as declared by the French *Sentinelles* Network, to week 8 (16<sup>th</sup> to 22<sup>nd</sup> February 2015).

### **The screening method**

We estimated VE using the screening method, a “case-base” design [13] able to provide early estimates of influenza VE [14, 15]. VE is calculated using the following equation:

$$VE = \frac{PV - PVC}{PV (1 - PVC)}$$

where PVC is the proportion of vaccinated among ILI cases (not laboratory confirmed) and PV is the proportion of vaccinated among the population. PV was obtained from robust administrative sources (CNAMTS - Caisse Nationale d’Assurance Maladie des Travailleurs Salariés, the main National Health Insurance System, covering about 85% of the French population) for the 2 risk groups: <65 y with chronic illness and ≥65 y [16]. Since influenza vaccines are not given to children under 6 months old they were excluded from the study. Individuals with missing age or vaccination status were also excluded. Vaccination status was

reported by GPs, based on GPs records or patient's declaration. Vaccines were considered as potentially effective if administrated at least 3 weeks prior to the onset of symptoms. Patients whose vaccination occurred <3 weeks prior to symptom onset were considered as not vaccinated.

### **Estimation of vaccine effectiveness**

VE estimates were stratified according to age as proposed by Farrington [17]. In practice, VE for all risk groups was estimated with a logistic regression model allowing a different offset in each age strata (two strata: <65 years with chronic illness;  $\geq 65$  years). Analyses were performed using the R software (version 2.15.3).

### **Ethical statement**

The protocol was conducted in agreement with the Helsinki declaration. Authorization was obtained from the French Data Protection Agency (CNIL, registration number #471393).

## **Results**

### **Description of the ongoing influenza epidemic in France**

During the 2014/15 winter, ILI incidence crossed the epidemic threshold in week 3 (from 12<sup>th</sup> to 18<sup>th</sup> January 2015), increased during the next 4 weeks from 239 cases per 100,000 inhabitants to 827 cases per 100,000 inhabitants (week 3 to week 6) and then decreased afterwards (from 802 per 100,000 inhabitants in week 7 to 723 per 100,000 inhabitants in week 8). Cumulated incidence rates during the beginning of this 2014/15 influenza epidemic (3,754 per 100,000 inhabitants) were already higher than the overall 2011/12 (2,276 per 100,000 inhabitants), 2010/11 (3,491 per 100,000 inhabitants) and 2013/14 (1,450 per 100,000 inhabitants) epidemics (data available on <http://www.sentiweb.fr>).

During the first weeks of this ongoing influenza epidemic - from week 3 to 8 of 2015, 10,730 ILI cases were reported by sentinel GPs. The positivity rate of at least one influenza virus for the ILI patients enrolled and sampled by GPs during the study period ranged from 63% (101/160; week 3) to 60% (120/201; week 8) and peaked at 73% (193/263; week 6). Positivity rate for A(H3N2) viruses among influenza laboratory confirmed ILI cases ranged from 63% (64/101; week 3) to 53% (63/120; week 8) and peaked at 64% (123/263; week 6) (Figure 1).

### **Vaccine effectiveness**

To estimate early VE of the ongoing influenza epidemic, the analysis was based on the 1,060 ILI cases reported by sentinel GPs belonging to the groups targeted for vaccination who did not have missing information concerning age, risk factors and vaccination status. Among all target groups, 400 ILI patients (37.7%) were vaccinated with the 2014/15 trivalent seasonal vaccine (Table 1).

Estimated VE in preventing ILI according to age group and risk factors using administrative data for the five last influenza epidemics are detailed in Table 2. The early VE of the 2014/15 influenza vaccine in preventing ILI was estimated to 32% for all target groups (95% confidence interval (CI): 23 to 40); 63% for patients aged <65 years with chronic illness (95% CI: 53 to 71) and 11% for patients aged of  $\geq 65$  years (95% CI: -4 to 23).

When considering all target groups, the VE estimated during the beginning of the 2014/15 influenza epidemic was lower than the VE value of the 2010/11, 2012/13 and 2013/14 influenza epidemics and close to the VE value of the previous A(H3N2) epidemic (2011/12). The VE estimate among patients aged  $\geq 65$  years was the lowest value estimated during the study period (Table 2; Figure 2).

## Discussion

Our analysis shows that the 2014/15 influenza vaccine did not offer the expected protection against the circulating viruses, particularly among elderly. The estimated VE for the prevention of ILI in primary care among the  $\geq 65$  years was the lowest estimate regarding the four previous seasonal influenza epidemics. Among the A(H3N2) viruses characterized from swabbed patients, a significant proportion were antigenically drifted from the vaccine component [2-5]. This low VE could be explained by concomitant A(H3N2) vaccine mismatch and by the immunosenescence process.

Overall, early VE estimated here among all target groups (32%; 95% CI: 23 to 40) and among the elderly (11%; 95% CI -4 to 23) are in agreement with the interim VE recently reported by other countries against laboratory-confirmed influenza cases [3-5]. The US reported a low VE against laboratory-confirmed influenza cases (all influenza viruses) in primary care of 23% (95% CI; 8 to 36) [3], similarly the UK reported a VE of 3.4% (95% CI; -44.8 to 35.5) [4] and Canada observed a VE of -1% (95% CI; -40 to 28) [5]. The early VE estimated in our study among the  $< 65$  years with chronic illness (63% (95% CI: 53 to 71) may seem high, but could be affected by confounding because selective rather than universal vaccination is recommended for this population [18, 19].

The screening method based on ILI cases used in this study allows estimating early VE for high-risk population targeted for vaccination over several influenza epidemics [14, 15] which was underlined as a current issue to guide policy decisions [20].

Considering ILI as an outcome leads to set up large enough sample database available in real time and standardized over years [21]. Samples based on laboratory-confirmed influenza cases are limited in size and not as quickly updated, especially for individual descriptions in our case. The use of a non-specific influenza outcome can bias VE estimates downward since



only a portion of ILI cases may be due to influenza virus infection [8]. However, considering ILI cases with a very specific definition [10], and only during the epidemic period - where influenza positivity rates of ILI were higher, allows to reduce this bias [22].

Moreover, as recently reported [23], the screening method using laboratory-confirmed influenza cases allows to provide similar estimates among the elderly as the test-negative design, that has been advocated as a valid method to estimate almost unbiased influenza VE. As the screening method using ILI cases (with a very specific definition) or laboratory-confirmed influenza cases provide VE estimates very close [22], estimation of VE by the screening method using ILI cases would be similar to those estimated by the test-negative design.

Consistency between proportions of vaccinated among ILI cases (PVC) and proportion of vaccinated among the population (PV) were controlled by using robust administrative data covering more than 85% of the French population to assess PV [22]. In order to minimize confounding factors analyses were restricted to high risk groups and stratified by age groups [17].

Finally, the stability of data and method used in our study allows estimating and comparing VE over several influenza epidemics even if values could be slightly biased. We assumed that if weak bias did occur, it should have affected similarly the results during the five influenza seasons here compared.

The low VE reported by several countries for this ongoing influenza epidemic shows the importance to estimate early VE during epidemics, especially among risk groups as elderly, to inform public health policy makers and remind specific recommendations as preventive actions (hand cleaning, masks) or influenza antiviral prescriptions for high-risk populations.

## Author's contributions

CS, CT: data management, data analysis; AF: draft of the manuscript; CS, TB, IB, DLB, SB, VE, MV, MB, CT, LC, VR, TH: interpreted data and reviewed the manuscript. All authors reviewed and approved the final draft of the manuscript.

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**Table 1.** Description of ILI cases included in the study, French Sentinelles surveillance network

| <b>Epidemic season</b> | <b>Period</b>   | <b>Groups (age, years)</b>   | <b>Total described</b> | <b>Total vaccinated n (%)</b> | <b>Vaccine coverage for the whole population (%)<sup>a</sup></b> |
|------------------------|-----------------|------------------------------|------------------------|-------------------------------|--|
| (Early) 2014/15        | 201503 - 201508 | 6m-64y with chronic illness  | 396                    | 74 (18.7)                     | 38.3 <sup>b</sup>  |
| (Early) 2014/15        | 201503 - 201508 | ≥65y                         | 664                    | 326 (49.1)                    | 51.9 <sup>b</sup>  |
| (Early) 2014/15        | 201503 - 201508 | Overall at risk              | 1060                   | 400 (37.7)                    | 48.9 <sup>b</sup>  |
| 2013/14                | 201405 - 201409 | 6m-64y with chronic illness  | 72                     | 9 (12.5)                      | 38.3   |
| 2013/14                | 201405 - 201409 | ≥65y                         | 111                    | 35 (31.5)                     | 51.9   |
| 2013/14                | 201405 - 201409 | Overall at risk              | 183                    | 44 (24.0)                     | 48.9   |
| 2012/13                | 201251 - 201311 | 6m-64y with chronic illness  | 286                    | 40 (14.0)                     | 39.1   |
| 2012/13                | 201251 - 201311 | ≥65y                         | 552                    | 180 (32.6)                    | 53.1   |
| 2012/13                | 201251 - 201311 | Overall at risk              | 838                    | 220 (26.3)                    | 50.1   |
| 2011/12                | 201205 - 201212 | 6m-64y with chronic illness  | 157                    | 38 (24.2)                     | 39.5   |
| 2011/12                | 201205 - 201212 | ≥65y                         | 411                    | 189 (46.0)                    | 55.2   |
| 2011/12                | 201205 - 201212 | Overall at risk              | 568                    | 227 (40.0)                    | 51.7   |
| 2010/11                | 201051 - 201107 | 6m-64y. with chronic illness | 211                    | 24 (11.4)                     | 37.2   |
| 2010/11                | 201051 - 201107 | ≥65 y                        | 214                    | 78 (34.4)                     | 56.2   |
| 2010/11                | 201051 - 201107 | Overall at risk              | 425                    | 102 (24.0)                    | 51.8   |

<sup>a</sup> data from CNAMTS (French National Health Insurance System)

<sup>b</sup> For 2014/15 influenza season, vaccine coverage of 2013/14 influenza season were used

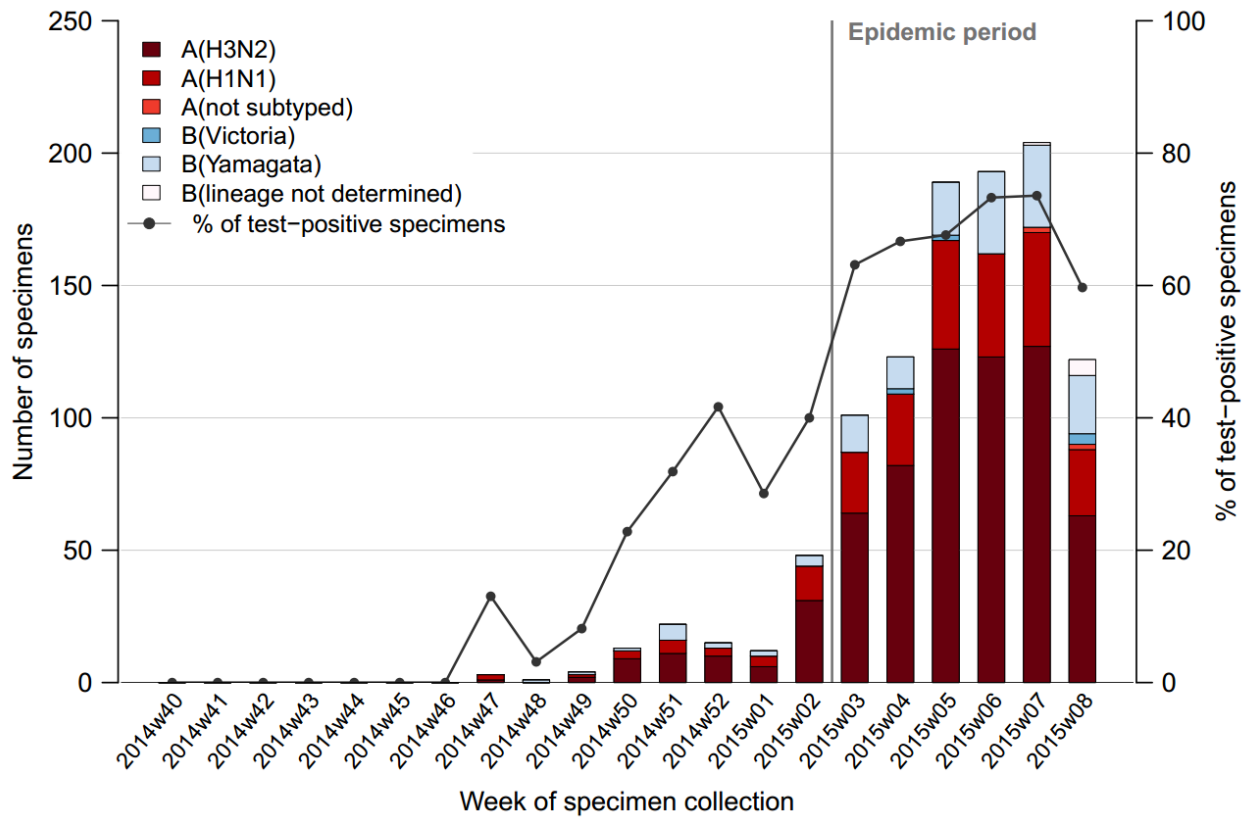
**Table 2.** Estimated vaccine effectiveness in preventing ILI for at-risk groups (6 months–64 years with chronic illness, over 65 year, and overall at risk), during five influenza epidemics between 2010/11 and 2014/15 and mismatch between dominant circulating strains and vaccine strains.

| <b>Epidemic season</b>       | <b>Groups (age, years)</b>  | <b>VE (%)</b> | <b>95% CI</b> | <b>Considered viral circulation<sup>b</sup></b> |
|------------------------------|-----------------------------|---------------|---------------|---|
| (Early) 2014-15 <sup>a</sup> | 6m-64y with chronic illness | 63            | 53 to 71      |   |
| (Early) 2014-15 <sup>a</sup> | ≥65y                        | 11            | -4 to 23      | A(H3N2)*  |
| (Early) 2014-15 <sup>a</sup> | Overall at risk             | 32            | 23 to 40      |   |
| 2013-14                      | 6m-64y with chronic illness | 77            | 56 to 89      |   |
| 2013-14                      | ≥65y                        | 57            | 37 to 72      | A(H1N1)pdm09 + A(H3N2)                          |
| 2013-14                      | Overall at risk             | 64            | 50 to 75      |   |
| 2012-13                      | 6m-64y with chronic illness | 75            | 65 to 82      |   |
| 2012-13                      | ≥65y                        | 57            | 49 to 64      | A(H1N1)pdm09 + B                                |
| 2012-13                      | Overall at risk             | 63            | 56 to 68      |   |
| 2011-12                      | 6m-64y with chronic illness | 51            | 30 to 66      |   |
| 2011-12                      | ≥65y                        | 31            | 16 to 43      | A(H3N2)*  |
| 2011-12                      | Overall at risk             | 36            | 25 to 46      |   |
| 2010-11                      | 6m-64y with chronic illness | 78            | 68 to 86      |   |
| 2010-11                      | ≥65y                        | 55            | 41 to 66      | A(H1N1)pdm09 + B                                |
| 2010-11                      | Overall at risk             | 65            | 57 to 72      |   |

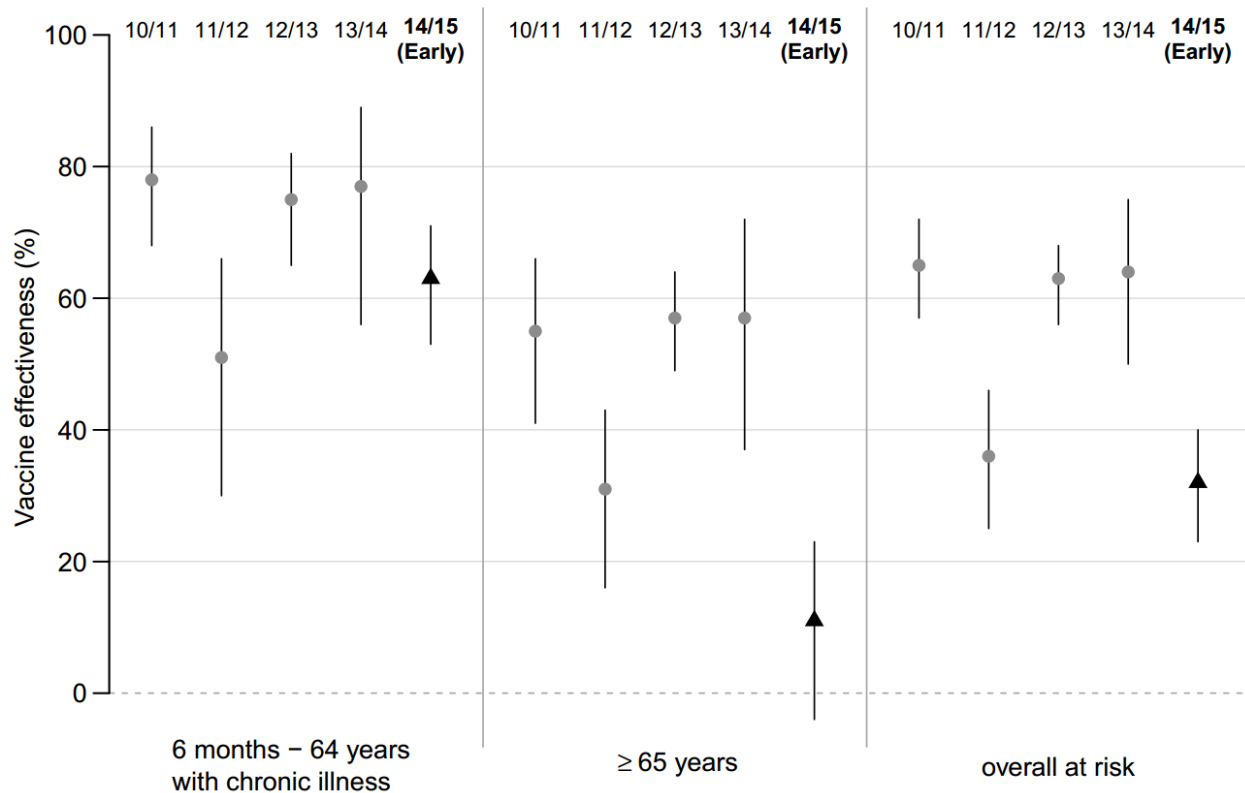
<sup>a</sup> from week 3 to week 8 of 2015.

<sup>b</sup> from Flunet database ([http://www.who.int/influenza/gisrs\\_laboratory/flunet/](http://www.who.int/influenza/gisrs_laboratory/flunet/)); Indicate the viral dominant type or subtype.

\*Indicate when the circulating strains differs from the vaccine's ones



**Figure 1** : Number of positive influenza-like illness patients swabbed by general practitioners who tested positive to at least one influenza virus by types/subtypes and proportion of laboratory confirmed influenza patients swabbed by week, French *Sentinelles* surveillance Network, 29 September 2014 – 22 February 2015 (n=1,923)



**Figure 2:** Effectiveness of trivalent seasonal influenza vaccine for five influenza epidemics (2010/11 to 2014/15), for at-risk groups (6 months–64 years with chronic illness, over 65 year, and overall at risk) estimated by the French *Sentinelles* surveillance Network; segments delimitate the 95% confidence intervals of the point estimates. For the 2014/15 influenza epidemic early vaccine effectiveness is reported (from week 3 to week 8 of 2015)