Impact of Vaccination on Between-Farm Transmission of Low Pathogenicity Avian Influenza Virus

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Introduction

Between 2000 – 2005 four LPAI (H7N1, H7N3 and H5N2) epidemics in Italy.

More than 500 infected farms, mainly meat type turkeys [1].

For control of LPAI outbreaks many control measures implemented, e.g. depopulation of infected flocks, vaccination.

Detailed data were collected on infected farms during Italian epidemics.

Goal

The main interest of this study was to analyse the impact of vaccination on between-farm transmission during the Italian LPAI epidemics.

Material and Methods

Control measures included in this study are shown in Table A.

Poultry were vaccinated with DIVA strategy with sentinel birds.

Monitoring for infection was in place.

Farm data available:

- ❖ Date of positive test outcome,
- ❖ Date of start of production cycle,
- ❖ Date of depopulation,
- ❖ Date of end of production cycle.

We estimated farm-level reproduction ratio (R_f) by transforming data into Susceptible (S) – Infectious (I) – Depopulated (D)-format.

Each week-record contained number of S, I and D farms present per week.

Generalized linear model with:

- ❖ Response variable: # new cases per week,
- ❖ Poisson distribution,
- ❖ Log-link,
- ❖ Offset: $\log(S(t)*I(t)/N(t))$, with $N(t)$ total number of farms present at time t.

Model resulted in transmission rate parameter β (per week).

R_f was estimated by multiplying β with mean farm-infectious period (5 weeks).

Various combinations of control measures implemented → we studied impact of vaccination in univariable and multivariable model.

Table A. *Definition of control measures included in the model*

# Name model	Control measure
1 Stamping	Stamping out of infected farm
2 Marketing	Controlled marketing: slaughtering of infected farm (in slaughter-house at the end of the production cycle)
3 Vaccination	Vaccination of farms
4 Density	Restocking ban; reduction of density of turkey farms
5 Homogenous	Homogenous areas (production cycles start at same time)

Table B. *Univariable model with periods coded as categorical variable*

Epidemic	Period	Period code (# weeks)	Control measures*	# Week records	# Cases	p-value	R_f
1 (H7N1)	**14/08/2000 – 20/03/2001**						
	24/07/2000 – 31/08/2000	1 (7)	-	5	32	REF	*2.15*
	01/09/2000 – 14/11/2000	2 (10)	1, 2	10	16	<0.0001	*0.53*
	15/11/2000 – 12/02/2001	3 (13)	1, 2, 3	13	21	0.002	*0.90*
	13/02/2001 – 26/03/2001	4 (6)	1, 3	6	2	0.46	*1.25*
2A (H7N3)	**20/06/2002 – 12/08/2002**						
	30/05/2002 – 12/08/2002	5 (11)	-	4	1	0.18	*0.56*
2B (H7N3)	**10/10/2002 – 29/09/2003**						
	19/09/2002 – 16/10/2002	6 (4)	-	3	9	0.91	*2.06*
	17/10/2002 – 25/10/2002	7 (1)	1	1	8	0.45	*2.90*
	26/10/2002 – 09/12/2002	8 (7)	1, 2	7	159	0.40	*1.83*
	10/12/2002 – 29/09/2003	9 (42)	1, 2, 3	42	188	<0.0001	*0.67*
3 (H7N3)	**15/09/2004 – 10/12/2004**						
	25/08/2004 – 11/10/2004	10 (7)	3, 4, 5	6	19	0.03	*1.14*
	12/10/2004 – 26/10/2004	11 (2)	2, 3, 4, 5	2	0	1.00	*0.00*
	27/10/2004 – 09/12/2004	12 (6)	2, 3, 5	6	2	0.005	*0.28*
4 (H5N2)	**11/04/2005 – 11/05/2005**						
	21/03/2005 – 25/04/2005	13 (5)	3	4	5	0.06	*0.88*
	26/04/2005 – 15/05/2005	14 (3)	1, 3	3	0	1.00	*0.00*

** See Table A for legend; REF: reference category for β*

Results

Table B shows R_f during various control periods of four epidemics.

After implementation of stamping out and controlled marketing R_f dropped from 2.15 to < 1 during epidemic 1.

Epidemic 2 showed reduction of R_f < 1 after vaccination started.

During epidemic 3 and 4 R_f was around 1 during implementation of vaccination.

Vaccination significantly reduced R_f in multivariable model, significantly < 1 in univariable model (results not shown).

Conclusion

Vaccination reduced virus transmission between farms during the Italian LPAI epidemics. During future LPAI epidemics vaccination should be implemented together with other measures, such as controlled marketing, to bring R_f <1.

Discussion

Vaccination showed clear between-farm spread reducing effect during epidemic 2. This effect was less clear during epidemic 1, where it seemed that vaccination increased transmission. However, during period 4 there were only 2 cases.

In multivariable analysis (after correction for other measures), vaccination did not seem to reduce R_f < 1, suggesting that vaccination alone was not sufficient.

Analysis of observational studies where control measures are rarely implemented on their own is not straightforward, as opposed to clinical trials. Therefore it is necessary to analyse field data with combination of multivariable and univariable techniques.

Reference

[1] Busani, L., Dalla Pozza, M., Bonfanti, L., *et al.*, 2007. Intervention Strategies for Low-Pathogenic Avian Influenza Control in Italy. Avian Dis. 51:470-473.