Effects of poultry management on risk of human exposure (at the community level)

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Background

- Exposure of humans mainly occurs through infected poultry (directly or indirectly)
- Therefore important to understand the risk posed by different populations of poultry
- Requires an understanding of:
  - factors leading to infection in poultry
  - poultry management techniques that influence the risk of infection
  - the course of infection in flocks of poultry and survival of virus in the environment
- Limited hard data from the field
  - that which is available is difficult to interpret due to study designs and ascertainment bias

Background

- 'Passive' disease surveillance in poultry subject to considerable reporting bias
  - not all cases reported (both non-recognition and deliberate)
  - not all infected flocks develop disease – especially ducks
- Studies based on official disease reports must be interpreted with caution (surveillance and reporting issues - tip of iceberg).
- 'Active' surveillance is targeted and usually biased towards populations considered high risk.

Dynamics of infection

- Most of the time, most poultry and most places where poultry are reared will not be infected/contaminated with H5N1 HPAI viruses ….. even in endemically infected countries

Exception :

Some live bird markets/trader's yards

Dynamics of infection

- Individual flocks/farms are probably not 'endemically infected' for extended periods
  - probably requires reintroduction of virus from outside
- How long does infection persist in:
  - a village with an outbreak in Indonesia? (are repeated outbreaks due to reintroduction)
  - in duck flocks? (given individuals only excrete for up to several weeks)

Dynamics of infection

- Most of the time the farm environment at any particular location in endemically infected countries will not be contaminated due to the short life span of virus outside the host
  - exceptions - cold weather
  - potentially, in water
    – available data summarized recently (EFSA Journal (2008) 715, 1-162) – but some conflicting results (Songserm (3 days) versus Brown et al (2007) (longer survival))
  - reduced survival for virus in field faeces vs faeces from SPF birds for H7N2 virus.
  - recent results from Vong et al 2008 EID – PCR positive environmental samples 12 days after last known poultry case …. no virus isolated
- More field data needed

Dynamics of infection

- We do not know, at any particular point in time, the probability that a particular flock will be exposed to virus (or of being infected).
- However, we can identify potential pathways of introduction and high risk practices that can lead to introduction of infection

Risk of virus incursion

- Each individual farm or flock has its own risk profile for introduction of pathogens and subsequent development of disease

Risk of virus incursion

- The risk of incursion of H5N1 HPAI viruses (or other pathogens) into a farm is determined by:

- the number of 'contacts'/links with the world outside the farm
- the probability of each of these 'contacts' involving infected or contaminated material

Risk of virus incursion

- This depends on
  - the level of infection in the area (hard to measure and varies over time)
  - the measures taken to reduce the likelihood of infection on/in items that enter the farm ('biosecurity' measures e.g. water treatment change of clothes)
- Effect of incursion depends on resistance of poultry (e.g. species, immunity)

- Farm types (or sector) provide a crude guide to the risk and consequences of infection


1


2


3


4

Risk – biosecurity versus threat

Biosec► Threat▼	High Type 1	Mod Type 2	Low Type 3	Low Type 4
V. Low				
Low				
Mod.				
High				

Risk of incursion into and sustained transmission within one or more farms in each FAO production sector/farm type - without vaccination

Dynamics of infection

- A few case-control studies on factors that correlate with infection with AI viruses on farms – reveal few unexpected insights (links to markets, external dead bird pick up service etc).
- 'Local' spread also occurs – mechanisms poorly defined
- Most endemically infected countries have a high proportion of poultry in farm types 3 and 4.
- Better quality disease investigations and tracing required

Dynamics of infection

- Seasonal effects
  - large numbers of young ducks bred for rice harvest,
  - Tet/Lunar New Year festival increases volume of trade and movement of poultry and probably increases risk of transmission (evidence – seasonal peaks and first principles)
- Role of hatcheries (poorly defined)
  - newly hatched chicks/ducklings should not be infected
  - hatchery and post-hatch hygiene often poor in poor countries
  - no data available on effect of infection on groups chicks or ducklings with maternal antibody exposed to virus at early age
- Role of middlemen in spread of infection
  - simplifying market chains assists in disease control but these chains develop for a reason and change is difficult to implement (vested interests)

Dynamics of infection

- Amount of virus produced in an infected flock depends on observational skills of owner and time from reporting disease to action (if he/she reports at all – may sell). Infection in a susceptible flock of chickens self limiting (highly fatal, no carrier state).
- Sick and dead birds represent a significant threat for human exposure especially if these birds are prepared for consumption. Available only during outbreaks of disease on farms but regularly in infected markets
- Cullers of infected flocks at high risk of exposure
  - difficulty in wearing PPE
  - few reported cases in cullers (exceptions H7N7, Pakistan 2007)
- Wild birds a potential source of virus for poultry and humans
  - hunters
  - are the negative results from wild birds in Europe in much of 2008 an aberration or a genuine change?

Vaccination

- In Vietnam, H5N1 HPAI viruses are being found mainly in flocks that have not been vaccinated or are not fully vaccinated
- Viruses are also found occasionally in vaccinated poultry in places where antigenic variants have emerged and where the vaccines in use afford less protection against variant strains
  - so far no human cases have been associated with 'major' antigenic variants that resisted poultry vaccines
- To my knowledge there have been no reported human cases associated with fully vaccinated populations of poultry (but limitations in the data need to be recognised)

Vaccination

- Most well vaccinated poultry will not excrete virus
  - if they do they will **not** do so for an extended period (evidence from numerous vaccination trials)
- Poorly vaccinated chickens with inadequate immunity are more likely to develop some clinical signs and even mortality than to develop true silent infection
  - field and experimental studies back this up
  - beware silently infected domestic ducks (vaccinated or unvaccinated)
- Limited cross immunity from infection with other AI viruses (e.g. H9 - cell-mediated? - Imai et al 2007, Seo and Webster 2001) might alter severity of clinical disease but
  - infected flocks would still show signs of disease

Vaccination

- Cannot prevent all infection with vaccination alone
- Many practical difficulties to overcome in implementing large scale vaccination in developing countries
  - current endemically infected countries will not get sufficient coverage to reduce Ro below 1
  - this will be achieved in individual flocks and in some areas
  - Ideal vaccine would improve levels of flock immunity and be easy to administer, but not available – need major research push in this direction

Vaccination

- Regardless of how well vaccination is performed in the field there will always be a 'tail' in the flock with low or no antibody
  - some flocks will not respond well to vaccination due to a range of factors (vaccine, vaccinator, concurrent disease etc)
- Vaccination will be required as a tool for control and prevention of H5N1 HPAI in the foreseeable future
- Significant antigenic variants have emerged but vaccination is not the only mechanism for generation of antigenic changes

Vaccination

- It is possible to reduce risks of emergence of antigenic variants by:
- reducing extent of virus multiplication (which vaccination can do)
- where possible, ensuring that vaccinated poultry are fully immunized with potent vaccines at the appropriate dose (issues relating to antigenic mass - see e.g. Kim et al J. Virol 2008)

Vaccination

- Over 13 billion doses of H5 vaccine used annually – mainly Chinese – therefore the quality of Chinese vaccine and the vaccination programs using Chinese vaccines are a crucial factor in the control of H5N1 HPAI and evolution of these viruses
- Effects of transport/market stress on resistance to infection in vaccinated poultry have not been studied

Some factors relating to human cases

- Most of the human cases have occurred in countries regarded as ‘endemically’ infected with >83% of reported human cases in four countries - Indonesia, China, Vietnam, Egypt

- Many cases appear to be in rural communities where there is a very close association between poultry and people

The future - prospects of eradication

- Avian influenza viruses are not eradicable
  - on-going risk of human exposure
- It is possible to eliminate certain strains of virus from countries or parts of countries at least temporarily
- The elimination of H5N1 avian influenza viruses, although ideal, is not a necessary precondition for zero human case reports
  - Vietnam in 2006, Hong Kong in 2001-2003 (virus in markets)
- H5N1 will not be eradicated globally in the next 10 years and possibly never
  - the threat to humans from H5N1 viruses will remain for some time

The future

- Global human population will grow
- The number of poultry reared globally will increase and much of the increase will be in developing countries
- Grain shortages and increased food prices could mean an increase in the number of small flocks of poultry fed on scraps or scavenging, even in developed countries
- Rise of so-called ethical consumption will probably result in more poultry reared outdoors (e.g. recent Californian legislative proposal)

The future

- Infected countries are shifting more poultry into more biosecure production systems but will not result in elimination of back yard poultry (changes in high risk practices needed)
- Progress likely to be slow (unless export driven – Thailand China, Brazil)
- Billions of poultry will still be reared in holdings with minimal biosecurity