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)

• 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
    - 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
### Risk – biosecurity versus threat

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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 endemic 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