THE ROYAL SOCIETY

The Academy of Medical Sciences

Summary of oral evidence: Dr Matthew Keeling

24 May 2006

Dr Matthew Keeling holds a joint appointment between the Mathematics Institute and the Department of Biological Sciences at the University of Warwick. As a mathematical modeller, his research interests involve population dynamics, mathematical biology, epidemiology, evolution, spatial systems and stochastic processes.

Members of the working group present were: Sir John Skehel, Professor Glynis Breakwell, Professor Neil Ferguson, Dr John McCauley, Professor Andrew McMichael, Professor Karl Nicholson, Dr Geoffrey Schild and Professor Robin Weiss.

Key points

Poultry models

Dr Keeling told the group that he is currently working on a project funded by Defra to develop a range of models (at both the within and between farm level) which can be used to predict the likely impact of an outbreak of avian influenza on the UK poultry industry and can help to advise on appropriate control measures. The project began recently so not much data is available at the moment.

This work makes full use of the GB poultry register, which provides a comprehensive snap-shot of the UK poultry farms. The register was set up by Defra to include all farms with over 50 birds. Detailed information is now available, for example, which companies are used to supply food to provide a network of links in and out of the farm. Dr Keeling's research is trying to model the flow of infection due to the movement of poultry and spread via personnel and vehicles; however it is difficult to establish the risk associated with each of the links and networks within and between farms.

Dr Keeling was asked what other information is missing. Transmission of avian influenza within a flock has already been examined (by others) and those parameters have been incorporated into the models, but such studies have only included up to 16 birds. No farm-scale models have been done to date. The risk of transmission from farm to farm, movement of people, or the risk associated with movement of food is unknown and must be assumed in current models. Data is also needed on the risk of transmission between birds.

Conducting experiments at the farm level rather than the individual bird level is impractical. Instead, data from the observed transmission of low pathogenic avian influenza (LPAI) has been used and the framework of the model exists, ready to incorporate further parameters in the event of an outbreak.

Dr Keeling was asked if he believes Defra's strategy for controlling the spread of a potential H5N1 infection will work. He told the group that his intuitive feeling is yes, although he has no firm evidence to back that up as not enough is known currently about the parameters. There could be situations where the policy will not work, of most concern is if multiple outbreaks occurred at a number of different locations at the same time.

International data
Dr Keeling was asked if data from other countries which have experienced outbreaks in poultry farms, for example Thailand, can be incorporated into the British models. Whilst data from Thailand has been used to underpin assumptions in his work and provides information on the spread between birds and between flocks, Dr Keeling believes that the UK poultry industry is very different and that the Thai data are not particularly helpful for that reason. Even data from other European countries such as Holland may be of limited value due to the uniqueness of the UK poultry industry. There has also been a problem with the quality of the data available from Thailand. Although their poultry sector is advanced, it is thought that there has been a cover-up of cases of infection. The quality of veterinary surveillance is also poor compared with Europe.

Dr Keeling was asked about the availability of international data from OIE. He told the group that OIE collect data from a surveillance perspective but it is often not detailed enough for his research purposes. Detailed data from affected regions is not available unless you have good links with people on the ground in a particular area. He has on-going collaborations with several international researchers.

Vaccination
Dr Keeling was asked about his views on vaccinating poultry. He told the group that the models being developed by himself and co-investigators will incorporate the affect of vaccination; these results show that vaccination of a poultry flock must be accompanied by the use of sentinel birds, to prevent the risk of un-detected outbreaks which could potentially be highly infectious. The population-level effect of vaccinating poultry will be sensitive to the type of birds vaccinated (presumably only layers), the efficacy of the vaccine and the coverage attained; it is difficult to assess this latter value which could be highly variable. In addition, we might need to consider the longer-term implications of mass poultry vaccination; such a control option would place strong evolutionary pressures on the virus and could potentially enhance the spread of novel mutations.

Biosecurity
Dr Keeling was asked about the importance of biosecurity in stopping the spread of the virus. He believes that the biosecurity of the top grandparent of stock is extremely good, but it is less efficient further down the chain. He felt that assessing and parameterising the levels of biosecurity is an important but difficult challenge.

Funding
Dr Keeling was asked if he considers the level of funding available for this area of research to be sufficient. He has received seed money from Defra for his study and is in discussions with them for further funding. Generally he believes that modelling is relatively cheap, but can have significant benefits.

Human pandemic influenza modelling
Dr Keeling was asked if he believes there are any gaps or weaknesses in the current human models. He told the group that we do not know what the human reaction to a pandemic will be and therefore it is hard to incorporate this into current models. Studies by social scientists and questionnaires may address some issues but we still don't know what the human reaction will be. For example, what effect will the media have? Will people leave the big cities or lock themselves up in their houses? The models already exist to capture the spread of influenza under `normal' conditions, but these new parameters will need to be included once the epidemic develops and the information becomes available.

Current models have used recent data but Dr Keeling suggests that census data from the 1950 or 60s could be incorporated together with information from previous pandemics as a test of the models reliability.