2002, issue 42 – Abstracts

AEEMA Meeting, June 13th 2002 - Strategies of collective vaccination to fight against animal diseases

The protection by vaccination

P.P. Pastoret

Smallpox is the first viral infection eradicated worldwide. This remarkable success is due to several factors including the availability of an efficacious vaccine, namely vaccinia, and the absence of a wildlife reservoir. The World Health Organization (W.H.O.) foresee in the same manner the eradication of human poliomyelitis and measles. The only animal viral disease which shares presently the same characteristics is rinderpest; there are several efficacious vaccines already available and the infection seems to be a dead-end if transmitted to susceptible wild species. Other animal viral infections do not share the same characteristics, either due to the lack of an efficacious vaccine (African swine fever) or to the existence of wildlife reservoirs such as the wild boar (*Sus scrofa*) for classical swine fever, the African buffalo (*Syncerus caffer*) for foot-and-mouth disease, bats for lyssavirus infections, etc. These diseases are more prone to a regional elimination than a complete eradication worldwide. Two methods are used to eliminate an animal viral infection, either vaccination or the strict application of hygienic measures including stamping out and incineration, or the association of both methods. Public opinion is more and more concerned about stamping out, when even necessary, especially if dealing with emerging zoonosis, such as Nipah virus infection of pigs in Malaysia. On the other hand, generalized vaccination (foot-and-mouth disease, classical swine fever, etc.) may be discontinued despite its efficacy, for macro-economic reasons. The solution may come from the use of marker vaccines associated with companion diagnostic tests owing the distinction between infected animals and simply vaccinated ones, using serological examination, such as for pseudorabies in pigs and infectious bovine rhinotracheitis. Some diseases may arise questions, such as rabies, despite the success of fox vaccination campaigns against rabies and the progressive elimination of terrestrial wildlife rabies in Europe, the existence of a permanently existing potential wildlife reservoir in bats is a threat, taking into consideration the variability of ARN viruses (quasi-species).

The strategies of collective vaccination against animal diseases

B. Toma, Barbara Dufour, M. Savey & F. Moutou

In the fight against animal diseases, the collective vaccination sometimes represents an indispensable action. The preparation of its decision of application, then its management and, later, the decision of its stop, raise numerous questions and imply to integrate into the answers' constituents of epidemiological, immunological, economic, psychological order. The objective of this statement is to set up the main aspects of the method of collective vaccination, aspects which will be illustrated by the following statements. Will be approached thus successively: The notion of collective vaccination, The objectives of the collective vaccination, The various types of strategies of collective vaccination, The factors to be taken into account, The usual modalities of elaboration of strategies in collective vaccination, and finally, The critical points and their control. The use in this method, of a sort of assurance quality thanks to the creation of a permanent group of experts intended to help the decision-maker(s) in the various stages of the method, introduced recently into the European rule to fight against classical swine fever (and in the course of introduction for foot-and-mouth disease), is to be recommended for any collective vaccination.

The vaccination against Aujeszky's disease in West of France

P. Vannier, P. Amar, K. Menier & X. Pacholek

Strategies of control programmes on Aujeszky's disease have been always relatively complex. They are representatives of examples of adaptation to complex and various epidemiological situations and to progressive adjustment to the achievement degree and the results of measures which are implemented. From 1983, regional eradication programmes against Aujeszky's Disease have been implemented at the national level. Programmes founded on sanitary measures have been applied in the majority of the French territory whereas in west of France, Brittany and Mayenne, medical measures have been implemented. In this western part of France, the results obtained were not always as they were expected. So, the control programme moved progressively to be adapted to the epidemiological situation. From 1987 to 1994, the generalized vaccination implemented did not diminish the prevalence of infection. From 1994 to 1999, the prevalence of infection decreased significantly, but the value remained stable during the last two years without allowing to reach eradication. New additional and complementary measures were implemented, including an accelerated culling of infected breeders or even stamping out of chronically infected herds. These last measures allowed to have encouraging results. The conditions of success of the use of vaccines as tools of control programmes are analysed and discussed.

The vaccination against ovine catarrhal fever in Corsica

D. Edderai, Christine Le Fur, P. Hendrikx, C. Grillet, S. Zientara, E. Albina & M. Gregory

Bluetongue appeared in Corsica in October 2000 and caused 49 outbreaks in two months. More than 80% of the ovine livestock was vaccinated with an attenuated vaccine during the 2000-2001 winter. This did not prevent 335 outbreaks of the disease to appear in Corsica from July to November 2001. In October 2001, a serological investigation was carried out with 13 vaccinated herds which withdrew themselves from the action of the wild virus through pastoral movement during the summer. The results show that the sero-conversion rate due to vaccination is very below the results of the vaccine effectiveness tests carried out by AFSSA. Field investigations made it possible to identify several potential causes of these bad results such as the time span between reconstitution and injection of the vaccine, difficulties of vaccination implementation and animal health condition. These results didn't call into question the intrinsic quality of the vaccine. Vaccination was therefore renewed, with convincing results, during winter 2001-2002.

Contribution of the modelling for the help to taking decisions during epizootics of foot-and-mouth disease

B. Durand, F. Moutou & O. Mahul

Several modelling studies have been used during the 2001 foot-and-mouth disease in Great Britain to justify the control strategy chosen by the animal health authorities. This study presents a deterministic model for foot-and-mouth disease epidemic which combines an epidemiologic model devised to generate the mean shape of an epidemic (in a given demographic and epidemiological context) with an economical model that computes the direct and indirect costs induced by such an epidemic. The model is used to compare three control strategies (without pre-emptive slaughter, with pre-emptive slaughter and with en emergency vaccination) in two French regions (Britany and Provence-Alpes-Côte d'Azur). Results show that the pre-emptive slaughter strategy is optimal in Britany and that the vaccination strategy is never optimal. However, these results do not rule out the use of an

emergency vaccination campaign if the epidemic turns out to have a large scale. The model has been used to formalize this difficult decision-making process through a comparison of the costs associated with the different options: immediately launch a preventive vaccination campaign, or not to do so and wait for further information about the probable scale of the epidemic. Finally, the interests and the limits of this study are discussed with regard to how modelling has been used for decision-making during the 2001 European epidemic.

AEEMA Meeting, June 14th, 2002 - Communications

Longitudinal study of the serological answer towards *Salmonella enterica* of fattening pigs in a sub-clinically infected herd

P-A. Beloeil, Claire Chauvin, P. Fravalo, N. Rose, K. Proux & F. Madec

A longitudinal survey was conducted in France in a sub-clinically *Salmonella* infected farrow-to-finish pig farm in order to describe the time-course of the serological response to *Salmonella enterica* in growing pigs from birth to slaughter by means of an indirect Salmonella ELISA testing. The age-related variation of the natural logarithm of calibrated optical density (COD) values of growing pigs was described by using two linear mixed models. From 8 to 61 days of age, the decrease in individual optical density was fitted with a model including the fixed effects of the batch, dam, individual birth weight and animal random effect on the intercept and slope. A second model including the fixed effects of the dam, the pen in which the followed animals were located during the fattening phase and the environmental contamination fitted the increase in serological results from 61 days of age until slaughter. The mean time of seroconversion was estimated occurring during the last third of the fattening phase. These results suggest the existence of clusters, such as batch, pen and litter of origin. The effect of environmental contamination on the serological reaction should ground the relationship between *Salmonella* shedding in growing pigs and serological infection.

The period of detection, an indicator of epidemiological surveillance. Application to the surveillance of Aujeszky's disease in slaughterhouses

V. Auvigne, Karin de Lange

The "infection-detection interval", an indicator of epidemiological surveillance. Application to the surveillance of Aujeszky's disease at the slaughterhouse. Serological surveillance of Aujeszky's disease in the French pig herd is based on routine blood testing of live animals. Depending on the regions and type of pig holding, these tests are conducted annually, every four months or, in rare cases, monthly. The carrying out of all or part of the sampling at the slaughterhouse is currently being studied. This method would allow a spread of the sampling over time, since the large majority of holdings send pigs for slaughter at regular intervals. For practical reasons, the sample taken in the abattoir is a piece of muscle. ELISA testing for ADV antibodies on meat juice is a highly specific method (>0.995), although the individual sensitivity is lower than the one used for ELISA on serum (0.93). In order to evaluate the epidemiological interest of a disease control programme based on samples taken at the slaughterhouse, the authors suggest to use as indicator the "infection-detection interval", e.g. the time needed for the detection of an infected holding. The parameters taken into account in the calculation of the indicator are: the individual sensitivity of the test, the number of samples, the interval between two sampling sessions, the delay in serological conversion, the evolution of the intra-herd prevalence. The indicator also takes into account the fact that, in practice, the period between infection and moment of sampling cannot be controlled. The

results show that, for an identical number of analyses, the chances of an early detection are higher with fragmented sampling of meat juice than with classical serological screening tests. The results were independent of the intra-herd prevalence, be it high (80%, typical in a non-vaccinated environment) or low (20%, typical in a vaccinated environment). Carrying out sampling in the abattoir would therefore improve the surveillance of Aujeszky's disease, and this in spite of a lower sensitivity. The use of "infection-detection interval" as indicator allows to underline the role of early detection of outbreaks in the success of eradication programmes.

Documentation on the free-of-disease situation with active surveillance in Switzerland. New approach

Ruth Hauser, D. Hadorn, J. Rüfenacht & Katharina Stärk

Switzerland has successfully eradicated diseases such as Brucellosis, Tuberculosis, IBR and EBL. The documentation of freedom from disease requires reliable information on the actual disease status in a susceptible animal population. The implementation of active surveillance (surveys) is an effective method to gain this information. For economic reasons, the sample size should be as small as possible, but large enough to achieve the required confidence level for a targeted threshold. For the design of the first survey for Aujeszky's disease in the pig population, we considered the sensibility and specificity of the tests. The evaluation of this survey was done with a simulation model. When conducting surveys repeatedly, various information sources about the disease status of the population, *e.g.* risk assessments regarding disease introduction and results of previous surveys, can be taken into account to adjust the required level of confidence for a follow-up survey. As a benefit, the sample size for national surveys can be reduced considerably. This paper illustrates this risk-based approach using examples of national surveys.

Risk assessment of certain diseases in pig farms according to biosecurity measures

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The present report describes the use of the risk analysis methodology to evaluate the risk of entry of six swine diseases (Aujeszky's disease, PRRS, pleuropneumonia, atrophic rhinitis, transmissible gastroenteritis and swine dysentery) in 173 farms regarding the biosecurity measures applied in each one of them. The average risk per year of introducing one or more diseases is 0.1218±0.0355. This risk is mainly attributable to Aujeszky's disease virus (0.0539) and PRRS virus (0.030). The most important risks of infection entry derive from people, either workers (0.0279) or visiting people (0.0517). Replacement gilts are also important (0.0263) and airborne transmission (0.0166) or diseases carried by animals other than pigs (dogs, cats, birds, rodents, etc.) can account for a lesser risk (0.0035). The program is based on parameters having a considerable degree of uncertainty but it allows the calculation of a satisfactory approximation of risk that can be used to correct or enhance the biosecurity measures applied in each farm.

New approach in the vaccination against the tick-borne diseases: the vaccine against the ticks using internal antigens

O. Sparagano

For many years vaccines have been developed to stop pathogens proliferating, some being transmitted by ticks. However, cross-protection against different pathogen species is low. Vaccines using tick tissues such as salivary glands or the full tick body gave mixed results with short-term protection, not always validated under field conditions. Surprisingly better results were obtained by using concealed antigens from the tick midgut. First generation molecules

such as Bm86, extracted from *Boophilus microplus* gut gave good protection but apparently not for all *B. microplus* strains. Therefore, new generation molecules such as Bm95 were produced to broaden the vaccine protection effects. This paper focuses on epidemiological issues linked to the development of vaccines against ticks.

Conjunctival REV 1 vaccination of adult sheep and goats in Tras-os-Montes, Portugal
Yolanda Vaz & F. Neto
Rev 1 vaccination is considered indispensable for small ruminant's brucellosis control in areas with high disease prevalence, especially when production systems are extensive and farms have a low technical profile. Vaccination of young replacement animals, with subcutaneous full dose, was applied in Portugal since 1972 and extended in the eighties. The decrease in brucellosis prevalence in 1990-1992, the implementation of the eradication programme co-financed by the EU in 1991, and the lack of human resources led to the progressive and early abandon of vaccination in the country. As a result, in certain regions like Trás-os-Montes, a mountainous area in the interior-north of Portugal, brucellosis prevalence started to sharply increase from 1997, resulting in heavy losses for the farmers, and a high cost for the Government. In 2000, 40% of slaughtered animals at national level came from this region. Flock prevalence reached 43.0% and animal prevalence 8.9%. Under these circumstances, a mass vaccination campaign appeared as the best option for the disease control, following extensive discussions among interested parties. Mass vaccination started in February 2001. In the first year of activity 67% of population was covered. The main problems were the occurrence of abortion in goat flocks where pregnant females were vaccinated and the restrain of animals' movements that was not well accepted by farmers. A follow-up of a sample of flocks to access vaccination efficacy at days 30, 120, 240 and 365 after vaccination was undertaken with good results. The spirit of dialog and confidence that was developed between farmers and the veterinary services created a good environment to keep the vaccination pressure, with the vaccination of all replacements, and the continuity of the programme until a better epidemiological situation is achieved.

Interest and limits of molecular tools for the diagnosis and epidemiology of bluetongue
S. Zientara, C. Sailleau, E. Breard & S. Hammoumi
After a brief description of the conventional methods of Bluetongue virus diagnosis, the authors describe the interest of the nucleotide sequence determination of the segments 2, 7 and 10. RT-PCRs were developed. The interests and limits of such methods are described as far as diagnosis and epidemiology are concerned.

A descriptive study of dog bites to children: Analysis of cases recorded at the emergency room of the paediatric hospital Trousseau (Paris)
Valérie Bordas, Stéphanie Meyer-Broseta, J-J. Bénet & M.P. Vazquez
The availability of a large, extensive set of registration data in a paediatric hospital has motivated this veterinary epidemiological survey. From 1991 to 1994, 237 dog bite cases represented 0.45% of emergencies in the Trousseau hospital. For children aged less than 3 years, the frequency of admission to the hospital reached 19.6% (compared to an average of 11.4% for children of all ages), with 75% of the lesions located on the head. These results confirm published results gathered in other countries. The large number of cases allows to show a link between sex and age ($p<0.001$) and to quantify the evolution of the sex ratio with age (significant dominance of the male sex only after the age of 12). The analysis of the links between age and certain circumstances (day, month, holidays, season) suggests further

studies that take into account the age and maturity of the child (< 3 years, 3-6 years, 6-10 years, >10 years).

Spatial analysis of the epizootic of West Nile virus infection in horses of Camargue on 2000: results and perspectives

Véronique Chevalier, B. Durand, G. Gerbier, M. Babinot, J-F. Michel, I. Toure & S. Zientara

In August 2000, a serological survey was undertaken as soon as the first equine clinical case of West Nile disease was confirmed. All equines located within a 10 km radius of laboratory-confirmed and probable cases were concerned. West Nile IgG antibodies were found in 8.5% of animals. First observations revealed the existence of a hotspot in a dry area, and suggested that, in 2000, *C. pipiens* was the main vector of the disease. To support this hypothesis, two spatial analyses were conducted. First, we built an analysis of the spatial distribution of horses according to their serological status. Then we provided a spatial analysis of the distribution of horses' groups according to their serological status in a pilot area. Even if the virus could not be isolated from mosquitoes, first results suggest that *C. pipiens* has been involved in the transmission of West Nile disease to horses in 2000.

Study on the procedure I.B.R. Aberrant results proposed by A.C.E.R.S.A.

E. Petit

To appreciate the earnings of positive and negative predictive values of a procedure of control of positive I.B.R. results, a mathematical and computer model is proposed to take into account the factors of dependence which can exist between the various tests used by the procedure. The numeric simulation with characteristics considered of the various tests shows a strong sensibility of the positive predictive value in the factors of dependence of the specificity of the reagent. It also shows a weak contribution or no of the procedure of control with regard to a simplified procedure which would contain only one new control. To be validated, the proposed model would deserve to be confronted with observations of ground realized on serums analysed with some reagent. Propositions are made on various protocols simplified of new control of serums during the controls of herds or introduction.