VACCINES FOR CONTROL, PREVENTION AND ERADICATION OF DISEASE IN FARMED DEER

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INTRODUCTION

The term "vaccination" was coined by Jenner nearly 200 years ago and is derived from the Latin word *Vacca* meaning "cow" after he discovered that infection with cowpox protected people from subsequent exposure to smallpox. In the 19th Century Pasteur discovered that injections of weakened or attenuated *Pasteurella multocida* bacterial cultures could protect against cholera in chickens Vaccines against swine erysipelas, sheep anthrax and rabies soon followed The use of these vaccines was empirical and it is only in the last 100 years that we have begun to learn how vaccines work although there is still much we still do not understand A useful introduction to immunology for veterinarians is found in the "Proceeding of Immunology in Clinical Practice", Foundation for Continuing Education, NZVA, 1985

RATIONAL USE OF VACCINES

The main reasons for vaccination are

a to protect the individual animal from infection and/or disease
b to prevent outbreaks of infection and/or disease in herds or flocks of animals
c to stop diseases spreading to uninfected areas and becoming established
d to eradicate diseases from areas where they have become established
e. to protect humans from zoonotic risks

In companion, equine and small animal practice the individual animal is the most important consideration and often the economic factors are much less important However, in large animal practice both flock or herd medicine and economics are important and intertwined Obviously deer fall into this category In a commercial situation, for vaccination to be justified it must be a cost effective means of preventing death or production losses, the cost of vaccination is less than the average annual loss, especially where occasional outbreaks can result in catastrophic loss, such as severe outbreaks of yersiniosis In other words, vaccination is largely like an insurance policy However, because most vaccines only give increased rather than absolute protection vaccination should be used as an adjunct to good management and husbandry and not as a substitute for poor management

Because deer have been farmed for only a relatively short period of time there are few veterinary products developed specifically for them Most anthelmintics, antibiotics and vaccines have been developed to combat diseases of economic significance in sheep and cattle and have subsequently been applied to similar conditions in deer, such as clostridial diseases and leptospirosis However, yersiniosis has emerged as a much more important disease for deer than other domestic animals and this has led to development of a specific vaccine In fact this is the only commercial vaccine developed specifically for deer in NZ (and probably the world)

VACCINES LICENSED FOR DEER

Currently there are only three vaccines licensed for use in deer in NZ, Leptavoid 3, Yersiniavax and Anti GNRF Vaccines (see Table 1)

Leptavoid 3 (Pitman-Moore)
"An inactivated vaccine prepared from highly antigenic strains of *Leptospira interrogans* serotypes *hardjo*, *copenhageni* and *pomona* For active immunisation against leptospirosis in cattle, deer, sheep and pigs, thereby reducing the risk of leptospirosis in humans Inject 2 mls subcutaneously in the anterior half of the neck "

Indications Leptospirosis is regarded as one of the more important diseases of farmed deer in NZ, especially in the North Island It has caused deaths in red and fallow deer calves and red hinds (Anon, 1980, Fairley *et al*, 1984, Fairley *et al* 1986, Anon 1989, Howell, 1991) and it has been blamed for poor breeding performance in fallow herds (Anon, 1990) The serovars *hardjo*, *pomona* and *copenhageni* have been isolated from deer in NZ and most cases of clinical disease have been associated with *pomona* There is also serological evidence

of infections with *ballum* and *tarassovi*, but their significance is not known, although *ballum* has been reported to have caused the death of a young stag in Scotland (Corrigall, 1978)

Apart from preventing production losses associated with leptospirosis in deer, leptospiral vaccination should also reduce the zoonotic risk for deer farmers, transport operators and slaughtermen

Efficacy. There is little published information to prove the efficacy of leptospiral vaccines in deer other than the serological responses to vaccination (Wilson & Schollum, 1984) Most animals responded to vaccination (primary followed 4 weeks later by secondary boost) with low titres of short duration similar to, although somewhat shorter duration than, those found in cattle Annual revaccination elicited measurable responses of 1 24 to 1:96 in the animals studied Although the measurable titres are of short duration it is believed that annual vaccination will provide resistance to leptospiral infection in deer, as has been demonstrated in cattle (Marshall *et al*, 1979, Mackintosh, et al, 1980) A vaccination trial of Leptavoid 3 conducted by Coopers Animal Health demonstrated natural infection and urinary shedding with *L hardjo* in 6 of 16 non-vaccinated deer while no isolates were recovered from 14 in-contact vaccinated deer The serological titres were of similar magnitude and duration to those reported by Wilson & Schollum (1984) (R Marchant, pers comm)

If the vaccine is as effective in deer as it is in cattle it should be possible to completely eradicate *Leptospira hardjo* and *pomona* from a deer herd if all the deer on a property are brought into a thorough vaccination programme Steps should be taken to prevent reintroduction from outside sources

Yersiniavax
This is the first commercial vaccine ever developed and licensed specifically for farmed deer It is a liquid vaccine of formalin killed *Yersinia pseudotuberculosis* (serotypes I, II and III) organisms with DEAE dextran adjuvant. It is recommended that deer be injected at 3 to 4 months of age with two doses of 2 ml of Yersiniavax 3 to 4 weeks apart

Indications Yersiniavax has been developed to protect deer against clinical yersiniosis caused by *Y pseudotuberculosis*. Yersiniosis is the most common bacterial disease of young red deer on deer farms in New Zealand Outbreaks of disease often affect 5-40% of mobs of weaners in their first autumn/winter, especially in cold, wet, stressful conditions The vaccine should be used to augment, rather than as a substitute for, good management practices Ideally, weaners should be well fed, well sheltered and exposed to as few stressors as possible Animals most at risk are those that have been underfed or fasted, transported and exposed to harsh climatic conditions. Vaccination is especially recommended for weaners that are being bought in, especially for feedlotting or grazing at high stocking densities Ideally weaners that are due to be transported should receive one dose of Yersiniavax at least 7-10 days prior to transport The second dose should be given 3 to 4 weeks later It would be reasonable to expect that sale weaners which have been vaccinated should attract a premium Recently captured deer may also benefit from vaccination prior to their release into a farming environment

Efficacy· Two experimental stress/challenge studies involving 267 weaners and one field trial involving 2463 weaners on 17 farms showed significant protection in vaccinated animals compared with unvaccinated controls (Mackintosh *et al* 1990, Mackintosh *et al* 1991, Mackintosh *et al* 1992)

Anti-GNRF Vaccine
This product was licensed for experimental trials to investigate its use as a rut suppressant in stags and is not available commercially

VACCINES NOT LICENSED BUT COMMONLY USED IN DEER

Clostridial Vaccines
A large number of deer farmers use multistrain (3, 4 or 5-in-1) clostridial vaccines against enterotoxaemia, tetanus, blackleg, malignant oedema and black disease These contain *Clostridium perfringens* type D (epsilon) toxoid, *C tetanus* toxoid, *C chauvoei* killed organisms, *C septicum* toxoid and *C oedematiens* type B killed organisms respectively

Indications Deer calves are usually vaccinated at or around weaning with 1 or 2 doses and adult hinds are boosted annually in spring to protect them at parturition and to provide for good colostral transfer to newborn calves Adult stags are often boosted annually (often in early summer at the time of velvet antler removal) to optimise protection against clostridial complications of wounds or bruising associated with fighting during the breeding season

Efficacy: Although clostridial vaccination of farmed deer is frequently recommended as part of disease prevention programmes both in NZ and Australia (Mulvaney, 1981, English 1984, McKenzie 1984, Scott 1987) there are little data on which to judge its efficacy Wilson (1984) monitored antibody responses in rising yearlings to either 2 ml or 4 ml doses of 5-in-1 clostridial vaccine Serological tests on pooled sera showed a nil antibody response to primary immunisation and a low peak response 14 days after secondary booster dose 6 weeks after the primary Titres fell to undetectable levels rapidly There was no difference in titres between 2 and 4 ml doses These peak titres were only 10-20% of the levels found in sheep, cattle and goats after the same vaccination regime. This begs the questions are these antibody responses in deer protective and, if so, for how long? As far as I know there have not been any further investigations and these questions have not been answered, except by the fact the few, if any, cases of clostridial disease have ever been reported in vaccinated animals

***Fusobacterium necrophorum* Vaccine**

The only vaccine currently available is FRA vaccine made by CSL This is a killed *F necrophorum* bacterin adjuvanted with aluminium hydroxide and is primarily marketed for the prevention of footrot caused by *F necrophorum* in cattle The manufacturers recommend an initial dose of 5 ml, a second dose of 10 ml 4 weeks later and a booster dose of 10 ml every 12 months For deer, most practitioners appear to use 2 ml doses

Indications *F necrophorum* causes foot abscesses, navel ill and necrotic stomatitis with secondary rumen, liver and lung abscesses in fallow and red deer weaners (McSporran 1984, Belton and Powell 1986, Bertram 1986, Evans 1987, Cook, 1989) Injuries to the mouth and feet from sharp objects, projections and thistles appear to predispose weaners to infection Practitioners and deer farmers in NZ and Australia claim that vaccination of fallow does with FRA significantly reduces the incidence of necrotic stomatitis It is recommended that weaners are vaccinated twice in autumn and that pregnant does are given an annual booster 3 weeks prior to fawning There is little information on the use of FRA vaccines in red deer to prevent foot abscess.

Efficacy There are no reports of controlled trials but some practitioners and farmers have had encouraging clinical results (Weeks 1988, Cook 1989) The product is not licensed for use in deer, and although no adverse reactions to vaccination have been reported it would be prudent to proceed with caution

POTENTIALLY USEFUL VACCINES FOR DEER

There are a number of diseases of farmed deer for which vaccines could be used or developed These include tuberculosis, Johnes Disease, deer parapox virus infection and parasitic diseases

Tuberculosis

Currently, research is underway to investigate the use of live attenuated vaccines against tuberculosis in deer (Buchan *et al* 1991) Initial studies are based on the BCG strain of *M bovis* and early results are encouraging (Griffin *et al* 1992)

Johnes Disease

If this disease becomes a significant problem in deer it would justify investigating the use of a live attenuated *M paratuberculosis* vaccine such as "Neoparasec" (Rhône Merieux) In the UK, a small number of isolated outbreaks of Johnes disease justified the experimental use of a Johnes vaccine, and although it reduced clinical losses there still appeared to be a high prevalence of subclinical infection found in yearling animals slaughtered for venison, 12 - 15 months after they were vaccinated as young calves (Buxton and Nyange, 1989) Unfortunately, Johnes vaccination causes cross-reactions with Tb tests and this may limit its usefulness unless specific markers or tests can be developed to differentiate reactivity

Deer Parapox Infection

Large outbreaks of deer parapox virus (DPV) infection have occurred on many properties throughout NZ resulting in velvet antler losses and a few deaths A preliminary trial of experimental infections with orf virus and DPV suggests that both give strong but not complete immunity to reinfection with DPV (Mackintosh and Smith 1987). Because these trials involved only small numbers it would be sensible to be cautious if contemplating use of either DPV or orf vaccines in the field Because no DPV vaccine is commercially available it would be necessary to have an autogenous vaccine made from DPV scab material, preferably from the farm involved Scabby mouth (Orf) vaccines are obviously available but are not licensed for use in deer In terms of accessibility, the axilla, is probably the most practical site for vaccination It should also be remembered that vaccination should only be contemplated when the DPV is already present on the property because obviously a live vaccine will introduce the virus (the same applies to orf vaccination) The length of protection is also not known, although generally speaking it appears that groups of stags which experience an outbreak of DPV infection one year rarely have another outbreak, although sporadic cases may occur subsequently This suggests that natural exposure produces long lasting protection from clinical disease although subsequent mild infections may occur If outbreaks occur each year in yearling stags then this may justify vaccination of weaners

Parasitic Disease

In the UK cattle farmers regularly dose calves with Dictol, a live attenuated (irradiated L3) lungworm (*Dictyocaulus viviparus*) vaccine This has been tried in deer, but without very convincing results (Corrigall *et al* 1986) However, it is likely that the strains of lungworm affecting deer are somewhat different from those of cattle, and it is possible that a specific deer lungworm vaccine may be more effective Preliminary investigations on such a vaccine were started at Otago University, but faltered when major difficulties were encountered with obtaining large enough numbers of infective L3 larvae to conduct trials It is hoped that the project can be resuscitated some time in the future

VACCINES OF THE FUTURE

Developments in vaccine technology are progressing rapidly at the moment and may open up new opportunities Subunit vaccines for rabies and Aujeskies disease have been licensed for use in domestic animals overseas recently and others are in the pipeline Vector vaccines hold considerable promise for the future These are live organisms (eg vaccinia and orf viruses) into which DNA sequences coding for other viral or bacterial proteins have been spliced As the vector organism replicates it also produces proteins from the inserted DNA sequences thus sensitising the animal For example it may be possible to incorporate clostridial DNA sequences into orf virus and scratch vaccination of animals with this virus would also immunise the recipients against clostridial diseases Some research teams are currently trying to incorporate extra DNA sequences into BCG vaccine to enhance its protective effect.

Other areas of research relate to antigen presentation and adjuvants Up until recently vaccines have been fairly crude and the use of adjuvants has been largely empirical Most commercial vaccines have relied on aluminium hydroxide and oil mixtures The former is only a weak adjuvant while the latter tends to provoke too severe a reaction Research into new oil combinations has reduced the degree of adverse reactions while retaining adjuvancy New compounds such as DEAE dextran are being used increasingly (eg, in Yersiniavax) to promote better antibody production In the future an increasing number of vaccines will incorporate more efficient adjuvants with fewer side-effects

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Table 1: Vaccines commonly used in deer.

	Composition	Adjuvant	Recommended use
Licensed for use in deer:			
Leptavoid 3 (Pitman Moore NZ Ltd)	Formalin killed *Leptospira hardjo* Formalin killed *Leptospira pomona* Formalin killed *Leptospira copenhageni*	Aluminium hydroxide	Dose rate 2 ml Weaners 2 doses, 4 weeks apart Adults Annual booster dose
Yersiniavax (MAF Technology Wallaceville)	Formalin killed *Yersinia pseudotuberculosis* serotypes I, II and III	DEAE dextran	Dose rate 2 ml Weaners 3-4 mo 2 doses, 3-4 weeks apart
(Anti GNRF vaccine - experimental use only)			
Not licensed for use in deer:			
Clostridial vaccines (various manufacturers)	May include up to 5 of the following *Clostridium perfringens* D toxoid *Clostridium tetanus* toxoid *Clostridium septicum* toxoid *Clostridium chauvoei* bacterin *Clostridium oedematiens* B bacterin	Aluminium hydroxide	Dose rate 2 ml Weaners· 2 doses, 4 weeks apart Adults. Annual booster dose Hinds Pre-calving Stags At velveting
FRA (Commonwealth Serum Laboratories)	Formalin killed *Fusobacterium necrophorum*	Aluminium hydroxide	Dose rate 2 ml ? (5-10 ml in cattle) Weaners. 2 doses, 4 weeks apart Adult hinds/does Annual booster dose pre-calving