

REVISIÓN

Fate of Neospora-seropositive animals: An opinion

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ABSTRACT

Neospora caninum is an abortive protozoon in cattle, which causes severe economic losses worldwide. Chronically infected cattle however develop immune responses protecting against further *Neospora* induced abortions. Controversy about losses other than abortion in *Neospora*-infected cattle still exists. Although, culling of seropositive animals has been recommended as a strategy for reducing economic losses due to *N. caninum*, there is no guarantee of escaping postnatal infection and abortion storms by having a “*Neospora*-sterile herd”. An inactivated vaccine has been demonstrated to reduce abortion rates. Antibodies generated by natural infection can not presently be differentiated from those induced by vaccination; however, since maternal antibodies disappear by 6 months in calves born to vaccinated heifers, a test-and cull strategy could be performed in replacement heifers before breeding and vaccination. This review article discusses control strategies for *Neospora*-infection in cattle, and provides suggestions for further research.

Key words: Bovine, Immunology, *Neospora caninum*.

INTRODUCTION

Neospora caninum (*N. caninum*) is an abortive protozoon in cattle, which causes severe economic losses worldwide¹. Although horizontal transmission can introduce the disease in to a naïve herd, vertical transmission is considered the most common mode of infection². Seropositive-animals are more likely to abort than seronegative ones¹; however, most infected dams transmit the parasite to their offspring without clinical signs^{1,2}.

As in other infections, an “equilibrium relationship” between host and parasite may be found in neosporosis. One result of such an equilibrium relationship is the vertical transmission of the parasite through multiple generations. In contrast, an imbalance between host and parasite

(with damage to the host) can lead to abortion³⁻⁵. To arrive at the best strategy for reducing reproduction and production losses due to *Neospora*-infection some questions must be considered:

- 1) What are the potential advantages and disadvantages for infection-free compared to infected herds?
- 2) Are there other economic losses besides *Neospora*-abortion that justify the culling of *Neospora*-seropositive animals?
- 3) Is vaccination a good strategy?

Each particular epidemiologic and economic situation can have its own rationale; nevertheless, the questions mentioned above can be partially answered based on existing evidence.

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2. Infected herds versus non-infected herds

In an endemic situation, a herd with high prevalence of *N. caninum* can have severe reproductive losses since *N. caninum* is a primary pathogen in cattle¹. The annual abortion rate can be as high as 10.6% to 17.3%⁶. However, although vertical transmission is going to be a frequent fact in an infected herd with high prevalence, the risk of “an abortion storm” caused by a new *Neospora*-exposure could be lower than in a naïve herd. It was demonstrated that chronically infected beef cows are less likely to abort or give birth prematurely than cows lacking a previous exposure to the protozoa, during an outbreak of neosporosis⁷. The development of immune mechanisms against *Neospora*-abortion has been suggested because the incidence of abortion decreases with the number of pregnancies⁸⁻¹¹. In addition, experimental evidence of protective immune responses against abortion and vertical transmission has been shown in chronically infected cattle¹² and naïve cattle inoculated with live *N. caninum* tachyzoites prior to mating¹³, respectively.

3. Performance of infected cattle

The economic impact of bovine neosporosis, including stillbirths, neonatal mortality, early fetal death, infertility, increased culling, reduced value of breeding stock and reduced milk production, was described¹⁴. However, there is continuing controversy about losses other than abortion in *Neospora*-infected cattle. For dairy cattle, two studies have demonstrated that *N. caninum* seropositive cattle produce less milk than uninfected cows^{15,16}. In contrast, seropositive cows produced more milk than seronegative cows¹⁷. Finally, no significant differences in milk production were found¹⁸. On the other hand, an improved udder health was associated with a *N. caninum*-positive serostatus in cows from farms without a recognized abortion problem¹⁹. In calves, no adverse effect of congenital infection on calf survival up to 3 months was reported²⁰. Moreover, a significant survival advantage for congenitally infected calves over non-infected calves was found in one of two dairy herds in a study²⁰.

For beef cattle, significant reductions in post-weaning weight gain, carcass weight, and economic return were observed in seropositive calves in a feedlot²¹, as well as significant

reductions in short-term weight gain and feed efficiency in post-weaning steers²². However in another study, pre-weaning performance of infected and uninfected beef calves were similar²³. Further investigation is needed to determinate whether the culling of seropositive cattle is justified because of production losses (milk production, post-weaning weight gain, carcass weight, short-term weight gain and feed efficiency) associated with *Neospora*-infections.

4. Control strategies

By using computerized models, economic losses were described in beef cow-calf herds^{24,25}. The return on fixed assets, as determined by subtracting variable costs from the annual income, was reduced by endemic *Neospora*-infection²⁵. Three control strategies (culling females that fail to calve, selling seropositive females and purchasing seronegative replacements, and excluding the daughters of seropositive dams as potential replacements) were also evaluated, and the removal of female offspring born to seropositive dams was the only economically beneficial strategy²⁵. The infection level in a dairy herd with low postnatal infection and predominantly congenital transmission was also reduced by culling seropositive animals²⁶. Nevertheless, there is no guarantee of minimizing the risk of postnatal infection and abortion storms by having a “*Neospora*-sterile herd”. Epidemic situations caused by primary *Neospora*-exposure are generally associated with high rates of abortion^{7,27,28}. Extreme strategies should be adopted in order to prevent horizontal transmission in a seronegative herd^{2,29} since many potential vectors or non-recognised host species could be involved in the life cycle of *N. caninum* and no proven methods are available to prevent postnatal infection. Such strategies could seem difficult to perform under extensive management or in areas where definitive hosts are abundant, but could be done in small herds under confinement. Finally, *Neospora*-seropositive cows with genetic superiority can remain in the herd as embryo donors, and *Neospora* free embryos can be obtained by using embryo transfer technology³⁰⁻³².

It has been demonstrated that an inactivated vaccine can reduce abortion rates³³. In their study the pre-vaccination infection status of the cattle and the degree of exposure post vaccination to

N. caninum were unknown; however the incidence of *Neospora*-abortion was 11.2% (49/438) in vaccinated animals and 20.8% (91/438) in the placebo group. In a recent work similar immune responses (titres of specific antibodies and concentrations of IFN- γ) were observed in naturally infected heifers and heifers inoculated with a killed whole *N. caninum* tachyzoite preparation during the second trimester of gestation³⁴. However, it is also known that such inactivated preparations are unable to prevent vertical transmission in cattle³⁵.

Antibodies generated by natural infection cannot presently be differentiated from those induced by vaccination. Nevertheless, since maternal antibodies disappear by 6 months in calves born to vaccinated heifers³⁴, a test-and cull strategy could be performed in replacement heifers before breeding and vaccination. Furthermore, every pregnant bovine (infected or non-infected) could be vaccinated and its progeny tested serologically before colostrum-intake or after 6 months of age to determinate its infection status. A new vaccine with a specific marker would be a useful tool for differentiating vaccinated from infected animals. Another desirable tool would be a diagnostic technique to detect specific antibodies found only in naturally infected animals. For instance, antibodies against a specific protein of 28kDa (homolog to BAG5 of *Toxoplasma gondii*), which is only present in bradyzoites³⁶, should be found in naturally infected cattle independently whether is vaccinated or not.

5. Conclusions

Although chronically infected cows transmit *Neospora*-infection vertically, they develop protective immune responses, which contribute to disease control after exposure to *Neospora*-oocysts. Culling of seropositive animals should be done only if external sources of contamination by *Neospora*-oocysts are controlled and introduction of infected animals can be prevented. There is still controversy about indirect losses due to *Neospora*-infections, which are not abortion related. Vaccination appears to be an aid to control of *Neospora*-abortions, and could also be implemented in association with a test-and cull strategy performed on female replacements before colostrum-intake or after 6 months of age.

RESUMEN

Neospora caninum es un protozoo que causa abortos en los bovinos produciendo importantes pérdidas económicas en todo el mundo. Existe evidencia reciente que demuestra que los bovinos infectados en forma crónica desarrollan mecanismos inmunes de protección contra el aborto causado por *N. caninum*. Por otro lado, la existencia de otras pérdidas económicas distintas del aborto es aún tema de controversia. Aunque la eliminación de bovinos seropositivos a la enfermedad a sido recomendado como medida de control sanitaria, un rodeo libre de infección no está exento de sufrir una exposición postnatal y "tormentas" de abortos. La utilización de una vacuna inactivada disminuye la tasa de abortos; sin embargo los anticuerpos vacunales no pueden ser diferenciados de aquellos producidos por infecciones naturales. Considerando que los anticuerpos maternos desaparecen a los 6 meses de vida, la serología de terneras de reemplazo antes del servicio y la vacunación podría ser una posible estrategia de control. Este artículo discute las estrategias de control para limitar la difusión de la neosporosis en bovinos y brinda posibles líneas de investigación.

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Acknowledgment: D.P. Moore thanks Dr. Douglas Hodgins (Ontario Veterinary College/U. of Guelph, Canada) and Dr. Carlos Campero (INTA, Balcarce, Argentina) for critical review and helpful comments.