Journal of
Dairy & Veterinary Sciences
ISSN: 2573-2196

Juniper Publishers
key to the Researchers

Mini Review
Volume 8 Issue 3 - December 2018
DOI: 10.19080/JDVS.2018.08.555738

Dairy and Vet Sci J

Application of Serological Tests to Assess the Efficacy of Foot-and-Mouth Disease Vaccination in Dairy Cattle with or without Viral Leucosis

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Submission: November 19, 2018; **Published:** December 03, 2018

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Abstract

Enzootic bovine leucosis is an infectious viral disease of cattle distributed worldwide that affect dairy cattle over 2 years of age. This disease produces changes in the animal´s immune system that may affect vaccine efficacy. During the last 10 years many reports have highlighted the association of BLV infection with a diminished or modified immune response against routinely used cattle vaccines. Our group has focused on studying the possible role of BLV infection on the immune response elicited by foot-and-mouth disease primo or multiple vaccinations making use of serological assays aimed to characterize the antibody response in terms of IgG-subtypes and avidity. These tools demonstrated to be very useful for analyzing the effects of BLV in FMD vaccine immunity. The use of simple high-throughput assays delving on the quality of the antibody response is paramount for assessing vaccine efficacy and can help in analyzing the impact of BLV infection at herd level.

Keywords: Bovine leucosis; Foot-and-mouth disease vaccines; Immune response; Serological tools

Mini Review

Enzootic bovine leucosis is an infectious disease of cattle induced by bovine leukemia virus (BLV). This retrovirus is worldwide distributed, and all cattle breeds are susceptible, although the incidence is higher in dairy cows and in animals over 2 years of age and increases with age [1]. Approximately sixty percent of infected animals do not display clinical signs of disease, and these animals are referred to as asymptomatic or aleukemic. Approximately 30–40% of BLV carriers will develop a persistent lymphocytosis, while fewer than 5% develop malignant lymphosarcoma [2]. The disease is difficult to control, and only a few countries have been able to eradicate the disease.

BLV infection impedes the normal function of the immune system, affecting cells of the innate and adaptive immunity [3]. A study performed in 1989 reported a possible impairment of the immune response against rotavirus in BLV-infected animals [4]. Considering that BLV is endemic in many countries and approximately 60% of the animals are asymptomatic, it is important to know how BLV infection impacts the immunogenicity of vaccines compulsory applied to cattle populations. Despite strong evidence of abnormal immune signalling and functioning, little research has investigated the large-scale effects of BLV infection on host immunity and resistance to other infectious diseases. Work performed along the last 10 years have shown that that BLV positive (by serology) dairy cows exhibit a decreased or modified immune response against primo-vaccination to a bacteria or inactivated virus-vaccine as compared to non-infected cows [5-8].

A compromised immune response to vaccination will be particularly detrimental for foot and mouth disease (FMD) control. FMD is endemic in many parts of Asia, Africa, and South America, where vaccination of susceptible populations is compulsory used as the major tool to prevent outbreaks of this extremely contagious virus. FMD has global consequences, costing an estimated USD $6–$21 billion each year in prevention expenditures and agricultural damage. A significant portion of this cost is undertaken by low- and middle-income countries that suffer huge economic losses from trade restrictions, both of animals and derived products [9,10].

Commercial vaccine formulations used in FMD vaccination campaigns are based on BEI-inactivated viral particles, and usually contain more than one virus strain, as immune responses induced by vaccination are not cross-protective between strains [11]. Protection against FMDV has been related to antibody levels induced by vaccination [12]. High levels of serum neutralizing antibodies and particularly, IgG1 levels are related to protection in vaccinated cattle [13,14]. Maintaining high levels of total antibodies against FMDV is paramount to prevent outbreaks. The well-characterized immune response elicited against FMDV using the current commercial vaccines allowed the analysis of the effect of BLV on the immune response elicited by FMD vaccine.

FMD vaccination represents then an excellent model to study the effect of BLV in the development of immunity. FMD vaccines are

well-controlled in many South-American countries. In Argentina, vaccination campaigns are applied under the supervision of the national authorities, certifying cold chain and correct application. Another advantage is the availability of ELISAs that allow a precise correlation with that can be used to study FMD-vaccine efficacy in the field [15,16]. Apart from assays measuring total antibodies, like liquid phase blocking ELISA used since the late eighties [17], there are also simple high-throughput serological tools to characterize the quality of the antibody response [14].

The quality of vaccine-induced antibodies, defined by isotype profile and avidity, has been identified as a defining factor in efficacy. FMDV isotype ELISAs for cattle sera were developed in the nineties [13]. They are indirect tests used to titrate anti FMDV IgG1 and IgG2 in sera. The rate between IgG1 and IgG2 titers has been related to protection against FMDV specially when studying cross- protection [14,18]. Isotypes bring information of the type of immune response, if it is related to antibody-mediated cellular responses or if they are mainly neutralizing responses. Avidity is another parameter of the "functional affinity" of specific antibodies. It is related to the interaction between polyclonal antibodies in a sample and the bound antigen. Avidity is influenced by the antibody serotype, their epitope-paratope affinity, the number of antibodies and their aminoacidic sequence. When vaccines stimulate the acquired immunity, antigen-specific B cells undergo somatic hypermutation and affinity-based selection, resulting in B cells that produce antibodies with increased avidity over germline antibodies. Avidity can be considered a landmark of efficient vaccination [19] and has been related to protection for many vaccines and diseases [20], used to discriminate between chronic and acute infections [21] and correlated to capacity of antibodies to neutralize viral infection in cultured cells [20,22].

Analysis of the isotypes of the antibodies induced against a virus strain in primo-vaccinated cattle revealed that IgM, IgG1 and IgG2 titres increased in both positive (BLV+) and negative (BLV-) heifers following FMD immunization, although IgM and IgG1 titters were higher in non-infected animals [5]. Levels of IgG2 can explain why the difference in antibody titters was only marginally significant when total antibodies were measured. The avidity index was lower in seropositive animals than that seronegative, meaning a reduced capacity of developing a protective immune response. These results demonstrated that BLV infection in dairy cattle modified the profile of antibody response to FMD primo-vaccination, biasing the isotype switch towards IgG2 though total antibody levels were marginally affected. These differences may be caused by the cytokine modulation exerted by BLV.

In a larger study [23] we measured anti FMDV antibodies from two-hundred milking cows (>2 years old) selected based on their BLV-serologic status (100 BLV+ and 100 BLV-). The animals were in two large farms in Argentina (500 animals each), one with low and another with high BLV prevalence. The aim of this study was to investigate if BLV-status could interfere with the efficacy of the FMDV-vaccination campaign. This is of interest in FMDV-endemic regions since the total FMDV-antibody titers induced through vaccination are necessary to prevent disease outbreaks. Here we showed that after repeated vaccination, levels and avidity of anti-FMDV antibodies were similar between BLV + and BLV- animals. Although primo-vaccination may be affected [5], repeated vaccination probably weakens this effect at a herd level, as animals may get infected with BLV at different times before or after their primo-vaccination. The use of avidity in this study allowed detecting individual vaccine failures that cannot be accounted by just measuring total antibodies. Our results suggested that BLV-status did not compromise the efficacy of routine FMDV-vaccination in cattle.

The use of serological high-throughput assays allowed to study if FMD vaccination was affected by the animal´s BLV serological status. These simple tools were useful to characterize the immune response at individual level and get a closer insight on the effects of this important viral disease of dairy cattle, revealing individual vaccine failures and helping to better characterizing the effect of BLV infection on the immune response induced by vaccination, at a herd level. These serological assays constitute important tools to assess vaccine performance in the field.

References

1. Johnson RK (1991) Bovine leukemia virus. Part I. Descriptive epidemiology, clinical manifestations, and diagnostic tests. Comp Cont Educ Proc Vet pp. 315-328.
2. Ghysdael J (1984) Bovine leukemia virus. Current Topics in Microbiology and Immunology. 112: 1-19.
3. Frie MC, Coussens PM (2015) Bovine leukemia virus: a major silent threat to proper immune responses in cattle. Veterinary Immunology and Immunopathology. 163(3-4): 103-114.
4. Archambault D, Morin G, Elazhary MA (1989) Possible impairment of rotavirus immune response in cattle infected with BLV. Veterinary Record 124(21): 570.
5. Puentes R (2016) Evaluation of serological response to foot-and-mouth disease vaccination in BLV infected cows. BMC Vet Res 12(1): 119.
6. Frie MC (2017) Dairy Cows Naturally Infected with Bovine Leukemia Virus Exhibit Abnormal B- and T-Cell Phenotypes after Primary and Secondary Exposures to Keyhole Limpet Hemocyanin. Front Vet Sci 4: 112.
7. Frie MC (2016) Reduced humoral immunity and atypical cell-mediated immunity in response to vaccination in cows naturally infected with bovine leukemia virus. Veterinary Immunology and Immunopathology 182: 125-135.
8. Erskine RJ (2011) Bovine Leukemia Virus Infection in Dairy Cattle: Effect on Serological Response to Immunization against J5 Escherichia coli Bacterin. Vet Med Int pp. 915747.
9. Smith MT (2014) Foot-and-mouth disease: technical and political challenges to eradication. Vaccine, 32(31): 3902-3908.
10. Knight-Jones TJ, Rushton J (2013) The economic impacts of foot and mouth disease - what are they, how big are they and where do they occur? Preventive Veterinary Medicine, 112(3-4): 161-73.
11. Doel TR (2003) FMD vaccines. Virus Research 91(1): 81-99.
12. McCullough KC (1992) Relationship between the anti-FMD virus antibody reaction as measured by different assays, and protection in vivo against challenge infection. Veterinary Microbiology 30(2-3): 99-112.

How to cite this article: Alejandra V C. Application of Serological Tests to Assess the Efficacy of Foot-and-Mouth Disease Vaccination in Dairy Cattle with or Without Viral Leucosis. Dairy and Vet Sci J. 2018; 8(3): 555738. DOI: 10.19080/JDVS.2018.08.555738.

13. Capozzo AV (1997) Total and isotype humoral responses in cattle vaccinated with foot and mouth disease virus (FMDV) immunogen produced either in bovine tongue tissue or in BHK-21 cell suspension cultures. Vaccine 15(6-7): 624-630.

14. Lavoria, MA (2012) Avidity and subtyping of specific antibodies applied to the indirect assessment of heterologous protection against Foot-and-Mouth Disease Virus in cattle. Vaccine 30(48): 6845-6850.

15. Robiolo B (2010) Confidence in indirect assessment of foot-and-mouth disease vaccine potency and vaccine matching carried out by liquid phase ELISA and virus neutralization tests. Vaccine 28(38): 6235-6241.

16. Robiolo B (1995) Assessment of foot and mouth disease vaccine potency by liquid-phase blocking ELISA: a proposal for an alternative to the challenge procedure in Argentina. Vaccine 13(14): 1346-1352.

17. McCullough KC, Crowther JR, Butcher RN (1985) A liquid-phase ELISA and its use in the identification of epitopes on foot-and-mouth disease virus antigens. Journal of Virological Methods 11(4): 329-338.

18. Brito BP, Perez AM, Capozzo AV (2014) Accuracy of traditional and novel serology tests for predicting cross-protection in foot-and-mouth disease vaccinated cattle. Vaccine 32(4): 433-436.

19. Lambert PH, Liu M, Siegrist CA (2005) Can successful vaccines teach us how to induce efficient protective immune responses? Nature Medicine 11(4): S54-S62.

20. Bachmann MF (1997) The role of antibody concentration and avidity in antiviral protection. Science 276(5321): 2024-2027.

21. Fox JL (2006) Immunoglobulin G avidity in differentiation between early and late antibody responses to West Nile virus. Clin Vaccine Immunol 13(1): 33-36.

22. Franco Mahecha OL (2011) Single dilution Avidity-Blocking ELISA as an alternative to the Bovine Viral Diarrhea Virus neutralization test. Journal of Virological Methods 175(2): 228-235.

23. Jaworski JP, Sala JM, Capozzo A (2018) Short communication: Bovine leukemia virus infection in adult cows does not interfere with foot-and-mouth disease vaccination. Journal of Dairy Science 101(12): 11247-11250.

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