

Vaccination Strategies for Emerging Disease Epidemics of Livestock

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KEYWORDS

- Vaccination • Immunization • Livestock immunization
- Foot and mouth disease

INTRODUCTION—TRADITIONAL VACCINATION

Vaccination of susceptible populations has been a successful and relatively safe and efficient means of disease prevention.¹ Smallpox immunization has achieved near-complete prevention of infection and transmission and has led to eradication of the disease from the planet.² In the case of smallpox, mass immunization of entire populations coupled with isolation and quarantine practices were effective. The vaccinia virus was used as the primary immunogen in these programs. Live vaccine virus delivered as an intradermal vaccine conferred immunity for up to 20 years. This same basic strategy has been used to vaccinate human and animal populations against many infectious diseases with variable degrees of success.¹ As the incidence of many infectious diseases has been drastically or completely reduced in some regions, immunization strategies have begun to focus on blocking infection and transmission from discrete outbreaks within specific geographic regions.³ The objective of these control strategies (as a component of integrated outbreak management) would be to limit disease spread from the initial point of disease outbreak. With respect to cattle populations, effective outbreak control would limit animal suffering and the economic impact of direct disease losses and potential trade restrictions.

The traditional and most common method of immunizing cattle populations is to broadly immunize potentially susceptible animals (which may be all animals in

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a herd setting) with particular emphasis on young animals and new herd additions.¹ The delivery of vaccines may be timed to provide immunity during seasonal periods of vulnerability (before breeding for example) or during times of production-related stress (such as pre- or postweaning periods). The success of immunization depends on the clinical efficacy of the vaccine, the immunologic potency of the vaccine, effective administration of the vaccine, and the use of sound herd management strategies.⁴

There are many factors that must be considered when making decisions regarding immunization strategies. Among these considerations is the most probable nature of the disease threat. If a disease agent is broadly disseminated throughout an animal population, there is little choice but to administer vaccines to large segments of the susceptible population. The decision to immunize, therefore, would be taken with consideration of the probability of disease exposure; health and economic risks of developing disease; the effectiveness, safety, and availability of approved vaccines; and the total costs and feasibility of immunization.⁵⁻⁷ It is recognized that even vaccines with less-than-perfect efficacy may provide substantial disease protection via herd immunity and disruption of disease agent transmission.⁸

IMMUNIZATION IN THE FACE OF EMERGING DISEASES

Potential outbreaks of newly emerging diseases represent a unique threat to cattle populations. Such outbreaks could occur from multiple types of sources, such as introduction of new infectious disease agents to a geographic region or emergence of unique strains of existing agents. The introduction of such agents could occur accidentally as people and materials frequently cross borders or it could occur intentionally as an act of bioterrorism or biologic warfare.⁹ In either case, if the point of introduction is quickly identified and appropriate animal trafficking rules are in place, targeted vaccination programs of susceptible and exposed animals surrounding index case herds may be a useful alternative to mass vaccination.¹⁰ Targeted vaccination programs may have distinct advantages, particularly if the numbers of available vaccine doses and vaccine banks are limited or if there are substantial logistic issues associated with mass vaccination of all animals and a threatened region.¹⁰ Also, if immunization may cause a significant number of adverse events or interfere with serologic investigations of disease spread, targeted vaccination strategies may reduce potential problems after immunization procedures are in place. In cases where disease introduction may be at multiple points or initial restriction of the animal movement fails, there may be no alternative to mass vaccination strategies. Mass vaccination may also be required if initial disease outbreak containment fails.

CHARACTERISTICS OF SUCCESSFUL TARGETED IMMUNIZATION PROGRAMS

North America, Europe, and other regions of the world are concerned with introduction of foot and mouth disease virus (FMDV) to highly susceptible cattle populations. The disease is endemic in many regions of Asia and South America.¹¹ Introduction of the virus could occur by accidental introduction of infected animals, accidental transfer of virus-contaminated materials, or the deliberate intention to cause harm. In this article, FMDV is discussed as a principle infectious agent as are the following critical components of a potentially successful targeted vaccination program: (1) nature of disease pathogenesis and transmission; (2) likelihood of early diagnosis and containment; (3) efficacy characteristics of vaccines available; (4) field effectiveness of immunization; and (5) alternative immunization strategies.

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