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A model of contagious bovine pleuropneumonia transmission dynamics in East Africa

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Abstract

The dynamics of contagious bovine pleuropneumonia (CBPP) transmission vary widely between livestock production systems. This paper describes the development of a homogeneous, stochastic, compartmental model for CBPP transmission in pastoral herds of East Africa. The model was built using parameter estimates based on data published in the literature and on observations of livestock owners obtained through participatory research. The basic reproduction number for CBPP in southern Sudan was estimated to range from 3.2 to 4.6. The homogeneous model indicates that the critical community size for the persistence of CBPP falls within the typical herd sizes for pastoral communities in East Africa suggesting that individual isolated herds are capable of maintaining infection indefinitely. Vaccination alone with currently available vaccines was unlikely to eradicate the disease.

Keywords: Contagious bovine pleuropneumonia; Modelling; Basic reproduction number; Participatory; Epidemiology; Policy-making

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1. Introduction

Contagious bovine pleuropneumonia (CBPP) caused by *Mycoplasma mycoides* subspecies *mycoides* (small colony) is a significant constraint to cattle production throughout most of sub-Saharan Africa. The disease is transmitted by direct contact and is characterized by its variable course and insidious nature. Clinical forms of the disease include the peracute, acute and chronic. Both transient, inapparent infection and the existence of persistently infected animals with encapsulated, infected sequestra are features of CBPP epidemiology. The disease is challenging to reproduce in the laboratory and study in the field. As a result, many aspects of the basic biology, epidemiology and immunology of CBPP are poorly understood (Turner, 1959; Masiga et al., 1996; Schneider et al., 1994).

Historically, CBPP was a disease of Europe, North America and Asia but was eradicated from the United States, Canada and most of Europe in the 19th century prior to the identification of the causative agent through clinical diagnosis, movement control and slaughter of suspected cases (Provost et al., 1987). Contagious bovine pleuropneumonia is believed to have been present in East and West Africa prior to the colonial era. The introduction of CBPP into southern Africa from Europe in 1854 and its subsequent spread as far north as Angola are well documented (Windsor, 2000). These regional differences are borne out by recent molecular epidemiologic studies that have demonstrated three African lineages of CBPP (Lorenzon et al., 2003).

Progress was made in controlling CBPP in Africa during the colonial era and the first two decades following independence. Large parts of Southern, Western and Eastern Africa were cleared using slaughter and movement control (Hammond and Branagan, 1965) which later incorporated testing strategies based on the complement fixation test (CFT) (Campbell and Turner, 1953; Huddart, 1960). As vaccines of moderate efficacy and duration of immunity became available, control programmes increasingly relied upon frequent vaccination and movement control.

In the 1980s and 1990s, economic crises engulfed many nations of Africa and the funding available for public veterinary services declined. Contagious bovine pleuropneumonia surveillance and control programmes were dramatically curtailed (Windsor, 2000). Public empowerment and the recognition of the pervasive negative effects of movement control on pastoral livelihoods decreased the acceptability of this tool as a control option. As a result, CBPP is again present throughout much of Eastern, Central and Western Africa (Masiga and Domenech, 1995). The East African focus has advanced south into Tanzania (Bolske et al., 1995) and subsequently spread throughout most regions of that country. The long-standing focus in Angola and northern Namibia has again invaded Zambia.

With the eradication of rinderpest from large parts of the continent, attention is returning to CBPP control. Socio-economic conditions have changed dramatically over the last 30 years, yet CBPP technology has remained essentially unchanged. Today, both movement control and test and slaughter policies would be costly to implement and poorly tolerated. Transhumant livelihoods systems are now recognized as rational and environmentally friendly foundations for sustainable development of arid lands (Niamir-Fuller, 1999). This leaves vaccination and controversial treatment regimes as the main possibilities for CBPP control in pastoral areas.