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Canine parvovirus in Australia: The role of socio-economic factors in disease clusters

S. Brady [a], J.M. Norris [b], M. Kelman [c], M.P. Ward [a,*]

[a] The University of Sydney, Faculty of Veterinary Science, 425 Werombi Road, Camden, NSW 2570, Australia
[b] The University of Sydney, Faculty of Veterinary Science, B14, McMaster Building, Camperdown, NSW 2006, Australia
[c] Virbac Australia, Milperra, NSW 1891, Australia

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ABSTRACT

To identify clusters of canine parvoviral related disease occurring in Australia during 2010 and investigate the role of socio-economic factors contributing to these clusters, reported cases of canine parvovirus were extracted from an on-line disease surveillance system. Reported residential postcode was used to locate cases, and clusters were identified using a scan statistic. Cases included in clusters were compared to those not included in such clusters with respect to human socioeconomic factors (postcode area relative socioeconomic disadvantage, economic resources, education and occupation) and dog factors (neuter status, breed, age, gender, vaccination status).

During 2010, there were 1187 cases of canine parvovirus reported. Nineteen significant ($P < 0.05$) disease clusters were identified, most commonly located in New South Wales. Eleven (58%) clusters occurred between April and July, and the average cluster length was 5.7 days. All clusters occurred in postcodes with a significantly ($P < 0.05$) greater level of relative socioeconomic disadvantage and a lower rank in education and occupation, and it was noted that clustered cases were less likely to have been neutered ($P = 0.004$). No significant difference ($P > 0.05$) was found between cases reported from cluster postcodes and those not within clusters for dog age, gender, breed or vaccination status (although the latter needs to be interpreted with caution, since vaccination was absent in most of the cases). Further research is required to investigate the apparent association between indicators of poor socioeconomic status and clusters of reported canine parvovirus diseases; however these initial findings may be useful for developing geographically- and temporally-targeted prevention and disease control programs.

Introduction

Canine parvovirus (CPV) is widely distributed in the global canine population and remains an important cause of morbidity and mortality despite extensive vaccination (Goddard and Leisewitz, 2010). The clinical presentation of the disease is most commonly acute enteritis, with severe leukopenia in young dogs up to 6 months of age; however in recent years a number of cases have been reported in older dogs (Goddard and Leisewitz, 2010; Decaro et al., 2008, 2009; Lamm and Rezabek, 2008). Survival rates have been reported to be as high as 80–95% when cases are treated early and aggressively, but as low as 9.1% without treatment (Goddard and Leisewitz, 2010; Prittie, 2004).

The persistence CPV in dog populations is attributed to its environmental resilience, virulence in susceptible populations, and the ability to mutate and avoid recognition by the immune system even in vaccinated individuals (Pereira et al., 2007). There are currently three widely recognised strains of canine parvovirus, namely, CPV-2a, CPV-2b and the recently characterised CPV-2c, although other strains have also been documented. The most recent study of Australian strains suggests that CPV-2a remains the most prevalent strain; CPV-2b was found uncommonly, and there was no evidence of CPV-2c infection (Meers et al., 2007).

Predisposing factors associated with the development of clinical parvovirus disease include stressors (such as weaning, overcrowding and parasite load), insufficient passive or active immunity, geographical region and the presence of co-pathogens (including canine coronavirus and intestinal parasites) (Goddard and Leisewitz, 2010; Kalli et al., 2010). Some of these factors are thought to increase the likelihood of developing clinical canine parvoviral disease by increasing the mitotic activity of mucosal cells (Goddard and Leisewitz, 2010).

The role of season and breed in the development of CPV is debatable with discrepancies in findings between studies; however, it is possible that the importance of these factors may vary geographically due to local factors such as extremes in weather, environmental viral loads, population density, and breed popularity (Goddard and Leisewitz, 2010; Kalli et al., 2010; Roth and Spickler, 2010; Houston et al., 1996; Godsall et al., 2010). Warmer months have been associated with increased reporting of cases

* Corresponding author. Tel.: +61 2 93511607.
E-mail address: michael.ward@sydney.edu.au (M.P. Ward).

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(Goddard and Leisewitz, 2010; Houston et al., 1996). The role of health disparities in infectious disease spread in public health has been recognised for many years, and is one consideration when planning disease control programs (Mbah and Gilligan, 2011). Similar studies in veterinary medicine are rare.

Studies in companion animal epidemiology have been limited by a lack of reliable and suitable data. Companion animal disease surveillance has mainly focused on zoonotic diseases such as rabies, for which case reporting is mandatory in most jurisdictions. Some specific research projects have been conducted, using data collected within the veterinary medical database (source data contributed by veterinary teaching hospitals across the United States) (Moore and Lund, 2009; Ward, 2002; Ward et al., 2002; Blanton et al., 2010). More recently a National Companion Animal Surveillance program for emerging and exotic diseases was established, with coverage of 2% of the entire dog and cat population of the US (Moore et al., 2005; Glickman et al., 2006), but was subsequently discontinued.

Until very recently, epidemiological data on diseases of companion animals in Australia could only be obtained by questionnaires and surveys used for a specific research objective (Sabine et al., 1982; Toribio et al., 2009). The introduction by Virbac Australia of a disease surveillance system, *Disease WatchDog*,[1] presents opportunities for the veterinary community to accumulate data (both temporally and spatially) on important diseases of dogs and cats relevant to their veterinary patients (Ward and Kelman, 2011). Evidence of spatio-temporal disease clustering indicates that some common factor(s) are contributing to disease propagation in specific areas and that targeted prevention programs will probably be effective in reducing disease occurrence (Ward and Carpenter, 2000). Analysis of data from the *Disease WatchDog* database may fill some of the current deficits in companion animal disease epidemiology (Ward and Kelman, 2011).

The objective of this study was to identify clusters of canine parvovirus-related disease that occurred in Australia during 2010 and to investigate potential factors contributing to these clusters. Specific aims were to analyse data from *Disease WatchDog* and describe the role that human socioeconomic indicators (relative socioeconomic disadvantage, access to economic resources, level of education, and occupation status) and dog factors (neuter status, breed, age, gender and vaccination status) might have played in the development of canine parvovirus-related disease clusters. We also wished to assess the role of geographical distribution of registered clinics in the formation of these clusters. The study endeavoured to further characterise canine parvoviral disease occurrence in Australia and provide insights into potential target areas for disease prevention.

Materials and methods

Data source

All case data for the study was acquired via the *Disease WatchDog* database, which was launched in January 2010 to log cases of diseases of dogs (including parvovirus) and cats occurring in Australia (Ward and Kelman, 2011). The database relies on veterinary practitioners and nurses entering case details; in exchange, practices gain access to real-time maps and data specific to their practice area. Such access to up-to-date epidemiological data enables practitioners to make more informed decisions regarding vaccination schedules and health prevention protocols relevant to their veterinary patients.

Records of all cases reported during 2010 were extracted. All cases of parvovirus-related disease reported were screened for duplicate entries to ensure that case reports were only included once in analyses. Each record entered was counted as one case report, even though there may have been more than one disease case when a litter was involved in the report. We assumed that a litter of puppies reported represented a single parvovirus infection event; because of the highly contagious nature of this disease, all puppies within a litter would presumably have been infected if the litter was infected and therefore represented one epidemiologic study unit. Each report (record) was allocated a case identification number and contained the following generic data fields: clinic name, veterinarian name, case occurrence date, animal name, suburb, postcode, state, species, breed, age (years, months, weeks), gender (male, female or unknown), neuter status (neutered, entire or unknown), disease (including canine parvovirus), case diagnosis (clinical presentation, ELISA snap test, PCR, immunofluorescence or other), case outcome (died, recovered, euthanased, tested positive but not clinically affected or treatment ongoing), vaccination status (vaccinated, unvaccinated or unknown), vaccine given and vaccine date. In addition, there was an optional field to record litters infected (number of animals in litter, number of animals in litter infected) although this additional data was not analysed in the current study.

Socio-economic data was sourced from the 2006 Australian census, made available by the Australian Bureau of Statistics.[2] Census data for each Australian postcode was obtained in summarised format from the Socio-economic Indexes for Areas (SEIFA) data cube. Indices recorded in the data set included education and occupation, economic resources, relative socio-economic disadvantage, and relative socio-economic advantage and disadvantage. The usual human population of each postal area code was also recorded. The index of socio-economic disadvantage is measured using financial and overall liveability factors, and can only be used as an indication of disadvantage (i.e. while a low score indicates greater relative disadvantage, a higher score does not necessarily indicate advantage; Pink, 2008).

The economic resources index is a ranking of postcodes based on indicators of high and low income and variables that correlate with high or low wealth, with higher scores indicating greater access to economic resources. Low education and occupation index scores represent postal areas with a high proportion of the population without tertiary qualifications, without jobs or with low skilled jobs; in contrast, a high score for this index suggests that a greater proportion of postcode residents are qualified and employed in skilled jobs (Pink, 2008). In addition, we used the relative socio-economic disadvantage index. A lower score for a postal area indicated greater relative disadvantage, with deciles also recorded for each postal area in relation to these scores (i.e. the lowest 10% of all postcode scores were allocated a decile of 1, while the highest 10% of all postcode scores were allocated a decile of 10; Pink, 2008).

Data management

Dog factors extracted from the recorded data in *Disease WatchDog* and analysed were neuter status, breed, age, gender and vaccination status. Neuter status was categorised as neutered or entire. Breeds were allocated to one of seven categories based on the Australian National Kennel Council breed standards.[3] Any cases recorded as crossbreeds or mixed breed were coded as mixed; the remainder of the dogs were classified by breed as toy, terrier, gundog, hound, working, utility or non-sporting. Three breeds reported in the extracted data are not recognised by the ANKC; these were subsequently classified as working (Bull Arab, Koolie) and non-sporting (Pit-bull).

Vaccination status was reported as vaccinated, unvaccinated or unknown. Vaccinated dogs were those that were recorded as having received at least one vaccination in their life. Based on reported information regarding date of vaccination, dogs classified as vaccinated were further categorised as vaccination incomplete (i.e. last recorded vaccination before 16 weeks of age), vaccinated within the previous 12 months, or non-recent vaccination (last recorded vaccination greater than 3 years prior to infection). Eleven cases classified initially as vaccinated were excluded from analysis of vaccination category due to errors (inconsistencies) in the reported dates of vaccine given.

The age of dogs was transformed from a years–months–weeks format to weeks only. For this transformation, it was assumed that 1 month consisted of 4 weeks and that 1 year consisted of 52 weeks. Gender was categorised as male, female or unknown. All clinic data was sorted according to postcode and month of registration in the database. Duplicate clinic entries (based on clinic name, postcode and state) were excluded, as were registrants identified as businesses other than Australian veterinary practices, and non-practising veterinarians.

Once disease clusters were identified at a postcode level, all recorded parvovirus cases were divided (based on postcode) into two data sets, namely, those cases within a cluster, and those not within a cluster. Although clusters were identified using a scanning window of 25% of the population and 2 week time period (see below), all cases recorded for these postcodes during the year 2010 were included in the 'within cluster' data set.

Data analysis

Maps displaying disease clusters, canine parvovirus case locations, and registered clinic locations were generated using ArcGIS v. 10 (ESRI). A retrospective space–time analysis scanning for clusters with high rates of disease was performed using the Space–Time Permutation model (SaTScan v9.1.1 Kulldorf M. and

[1] See: www.diseasewatchdog.org.

[2] See: www.abs.gov.au.

[3] Australian National Kennel Council Breeds; see: http://www.ankc.org.au/Breeds.aspx (accessed 26 January 2012).