Preventive Veterinary Medicine 153 (2018) 77–83

Contents lists available at ScienceDirect

Preventive Veterinary Medicine

journal homepage: www.elsevier.com/locate/prevetmed

Risk factors for cutaneous myiasis (blowfly strike) in pet rabbits in Great Britain based on text-mining veterinary electronic health records

Rachel Turner[a,1], Elena Arsevska[b,1], Beth Brant[b], David A. Singleton[b], Jenny Newman[b], PJ-M Noble[a], Philip H. Jones[b], Alan D. Radford[b,*]

[a] Institute of Veterinary Science, University of Liverpool, Leahurst Campus, Chester High Road, Neston, CH64 7TE, UK
[b] Institute of Infection and Global Health, University of Liverpool, Leahurst Campus, Chester High Road, Neston, CH64 7TE, UK

ARTICLE INFO

Keywords:
Blowfly strike
Myiasis
Rabbits
Risk factors
Seasonality
Electronic health records

ABSTRACT

Blowfly strike is a devastating and often rapidly fatal disease in rabbits. In Great Britain (GB), *Lucilia sericata* is the primary causative species. Despite its severity, there has been minimal investigatory work into the disease in rabbits. Here we used text mining to screen electronic health records (EHRs) from a large sentinel network of 389 veterinary practices in GB between March 2014 and April 2017 for confirmed cases of blowfly strike in rabbits.

Blowfly strike was identified in 243 of 42,226 rabbit consultations (0.6%), affecting 205 individual rabbits. The anatomical site of recorded blowfly strike lesions was overwhelmingly the perineal area (n = 109, 52.4%). Less commonly lesions were observed affecting other areas of the body (n = 9, 4.3%) and head (n = 8, 3.8%); in 83 consultations (39.9%), the affected area was not specified. Of the rabbits presenting with blowfly strike, 44.7% were recorded as being euthanized or died.

A case control study was used to identify risk factors for blowfly strike in this population. Whilst sex and neuter status in isolation were not significantly associated with blowfly strike, entire female rabbits showed a 3.3 times greater odds of being a case than neutered female rabbits. Rabbits five years of age and over were more than 3.8 times likely to present for blowfly strike. For every 1 °C rise in environmental temperature between 4.67 °C and 17.68 °C, there was a 33% increase risk of blowfly strike, with cases peaking in July or August. Overall blowfly strike cases started earlier and peaked higher in the south of Great Britain. The most northerly latitude studied was at lower risk of blowfly strike than the most southerly (OR = 0.50, $p < 0.001$). There appeared to be no significant relationship between blowfly strike in rabbits and either the sheep density or rural and urban land coverage types.

The results presented here can be used for targeted health messaging to reduce the impact of this deadly disease for rabbits. We propose that real-time temporal and spatial surveillance of the rabbit disease may also help inform sheep control, where the seasonal profile is very similar, and where routine surveillance data is also not available. Our results highlight the value of sentinel databases based on EHRs for research and surveillance.

1. Introduction

Cutaneous myiasis, or blowfly strike, occurs worldwide, and is caused by a variety of species of fly (Bisdorff and Wall, 2006; Hall, 1997). Rabbits, which are a frequently kept as companion animals in Great Britain (GB) (Sánchez-Vizcaíno et al., 2017), are commonly affected (Cousquer, 2006). Using a retrospective questionnaire study, it was shown that 94.5% of practices in England and Wales reported treating at least one case of blowfly strike between May and September 2005, with many affected rabbits dying (Bisdorff and Wall, 2006). Rabbits affected by blowfly strike typically develop tachypnoea, hypothermia, anaemia, considerable soft tissue damage, and if left untreated, can develop toxaemia, shock and rapid death (Ipek and Ipek, 2012). Overweight rabbits may be less able to clean themselves and thus more prone to blowfly strike (Cousquer, 2006). As such, blowfly strike is a notable welfare concern in affected animals.

The disease also heavily impacts on sheep, and is associated with a heavy economic burden to the industry, estimated at $280million dollars per annum in Australia (Sotiraki and Hall, 2012). In GB, 75% of farms had been struck with blowfly strike (Bisdorff et al., 2006), particularly in the south of England, with approximately 1.5% of sheep affected each year (French et al., 1995), reaching 12–15% on some

* Corresponding author.
E-mail address: alanrad@liverpool.ac.uk (A.D. Radford).
[1] These authors contributed equally.

https://doi.org/10.1016/j.prevetmed.2018.03.011
Received 10 November 2017; Received in revised form 1 March 2018; Accepted 13 March 2018

farms in the absence of blowfly strike control (Broughan and Wall, 2007).

The parasite species most commonly associated with blowfly strike in GB is *Lucilia sericata,* the Common Green Bottle Fly (Hall and Wall, 1995), the life-cycle of which primarily drives the seasonality and incidence of disease. Data on the life cycle of *L. sericata* is generally available from work on sheep, although likely to be similar in rabbits. The predicted average minimum threshold temperature below which oviposition does not occur is approximately 8.5 °C (Broughan and Wall, 2007). Flies are attracted to susceptible areas by volatile substances produced by bacterial degradation of skin and wool (Ashworth and Wall, 1994). At permissive temperatures, an individual adult female fly can lay about 200 eggs on their vertebrate host, mainly on damp areas of the skin or coat (usually anal and perineal areas) (Sotiraki and Hall, 2012). Hatching takes approximately 24–48 h, and when they hatch, the larvae move down the fur toward the skin where they moult twice (Wall and Lovatt, 2015); this process takes about three days to complete. After feeding on the superficial epidermis, lymphatic exudates and necrotic tissue, the wandering third stage larvae drop from the host and enter the soil. In the autumn, they enter a winter diapause and only pupate and emerge the following spring.

Despite the severity of the disease, to date there has been little attempt to assess the risk factors for rabbit blowfly strike across GB. Furthermore, there is no compulsory surveillance for blowfly strike in GB in any species and thus the evaluation of disease burden is a challenge. Recently, electronic health records (EHRs), which can be collected at large temporal and spatial scales and in real-time from sentinel networks of veterinary practices, have been used to provide new insight into population health for a range of diseases and syndromes (Arsevska et al., 2017; O' Neill et al., 2017), and including ticks (Sánchez-Vizcaíno et al., 2016; Tulloch et al., 2017). The aim of this study was to identify the prevalence, seasonality and risk factors of blowfly strike in companion domestic rabbits using veterinary EHRs available collected from the Small Animal Veterinary Surveillance Network (SAVSNET), a sentinel network of veterinary practices across GB (Sánchez-Vizcaíno et al., 2017).

2. Material and methods

2.1. Data extraction and inclusion criteria

Electronic health records (EHRs) were collected in near real-time through SAVSNET from volunteer veterinary practices across GB; a full description of the data collection protocol has been described elsewhere (Sánchez-Vizcaíno et al., 2017). Briefly veterinary practices using practice management software previously made compatible with SAVSNET participation and data exchange were recruited based on convenience. In participating practices, data is collected from each booked consultation (where an owner has booked an appointment to see a veterinary surgeon or nurse). Owners attending participating practices are given the option to opt out at the time of their consultation, thereby excluding their data. For those that participate, data are collected on a consultation-by-consultation basis and include information about the animal (e.g. species, breed, sex, neuter status, age, owner's postcode, insurance and microchipping status), as well as free-text clinical narrative (subsequently automatically redacted for inadvertent personal identifiers), treatments given, and the vaccination history (Sánchez-Vizcaíno et al., 2017). Data collection and use by SAVSNET is ethically approved by the University of Liverpool Research Ethics Committee (RETH000964).

In order to explore the seasonality and risk factors for blowfly strike, we defined cases as those animals that were presented for consultation with active blowfly strike lesions, visually confirmed and recorded by the attending veterinary practitioner.

Clinical narratives that had been processed to remove any personal identifiers, were filtered to identify narratives referencing blowfly strike using regular expressions (regex; https://en.wikipedia.org/wiki/Regular_expression) to detect the word blowfly strike, identified term variants and misspellings. The final regex (Supplementary figure) when applied to the full SAVSNET rabbit database of 42,226 rabbit consultations identified 443 consultations. This data was manually read by two authors (RT and EA), identifying 243 consultations (54.8% of those extracted by the regex) that satisfied the case definition of active blowfly strike disease. Of these 243, any rabbits that had visited the veterinary practitioner more than once in a month were considered to be suffering from the same episode of blowfly strike and thus only the first consultation was kept. Furthermore, rabbits with incomplete data (e.g. age or owner postcode not recorded) were also excluded from analyses. The final dataset consisted of 205 rabbits presenting with blowfly strike; three of these rabbits had two separate blowfly strike episodes longer than one month apart giving a total of 208 episodes of blowfly strike (Fig. 2).

In order to determine risk factors associated with blowfly strike, we conducted a retrospective case-control study; control rabbit consultations (979, 1 case: 4 controls) were randomly chosen from those rabbits that had never presented for an episode of flystrike (based on the clinical narratives of the electronic health records).

2.2. Animal data

For each case and control, the unique consultation ID was used to extract the rest of the information for that animal, including the postcode of the owner, the breed, sex, neuter status and date of consultation. Age was calculated as the difference in years between the date of birth and the date of consultation of each animal, and was categorised into quintiles (Table 1). Manual reading of clinical narratives was also used to classify if recorded the site of blowfly strike lesions, body condition score, as well as any other relevant clinical or outcome data. Information on the housing of the rabbit was not routinely available.

The SAVSNET database also collects the breed of the animals. Some breeds have longer coats or more dense fur, which may predispose them to faecal soiling (Cousquer, 2006). However, of the 208 cases of blowfly strike identified, 140 had missing information about the breed, and thus the breed of the rabbit was not analysed.

2.3. Climate data and seasonality

The seasonality of blowfly strike was evaluated by meteorological season: winter (December to February), spring (March-May), summer (June-August) and autumn (September to November). The monthly average (night and daytime) temperature (°C) and precipitation (mm) were assessed, to further quantify the influence of climate on the occurrence of blowfly strike (Fick and Hijmans, 2017). For each owner postcode and month of consultation, we extracted the average monthly temperature and precipitation using the 2.5 min spatial resolution rasters freely available from the WorldClim version 2 at: http://worldclim.org/version2 (Fick and Hijmans, 2017).

Furthermore, the spatial risk of blowfly strike was evaluated based on the coordinates (latitude, longitude) of owner postcodes. Latitudes were divided into five equal quintiles, each containing 20% of the cases, with Lat1 being the most southerly quintile. For each quintile the number of blowfly strike consultations per one thousand total rabbit consultations was calculated for each month.

Data on urbanisation was obtained from the 30 s spatial resolution raster of the dominant aggregate class version of the Land Cover Map 2015 available from the Centre for Ecology and Hydrology at: https://www.ceh.ac.uk/services/land-cover-map-2015. More precisely, the dominant cover of GB is divided into ten classes, i.e. 1 = broadleaf woodland, 2 = coniferous woodland, 3 = arable, 4 = improved grassland, 5 = semi-natural grassland, 6 = mountain, heath, bog, 7 = saltwater, 8 = freshwater, 9 = coastal, 10 = built-up areas and gardens (Rowland et al., 2017). For each point that represents the owner's