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Epidemiology and Origin of Canine Transmissible Venereal Tumours Diagnosed in the UK: Evidence of Rising Import-Associated Cases

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ABSTRACT

Canine transmissible venereal tumour (TVT) is a neoplasm that spreads between dogs through direct physical contact, most often involving the reproductive tract. Lesions usually develop on genital surfaces. TVT is not regarded as endemic in the United Kingdom (UK), and cases are typically linked to imported animals. This study aimed to characterise affected patients, describe temporal and geographic patterns, and document countries of origin for dogs identified with TVT in the UK. Electronic pathology records (EPRs) from four UK veterinary diagnostic services spanning 2010–2019 were queried using the keywords "venereal" or "TVT." Each positive record was reviewed for confirmation of TVT, and descriptive summaries were produced. Results: Of 182 EPRs containing the selected search terms, 71 were confirmed as TVT. Country of origin was recorded in 36 dogs (50.7%), with Romania representing the most frequent source (n = 29). Cases were noted in all constituent UK nations, with England accounting for most reports (64, 90.1%). The rate of diagnosed TVT increased over the study period ($z = 2.78$, $p = 0.005$). The number of TVT diagnoses within the UK is rising, with most known cases involving imported dogs. Because of the study design, local transmission cannot be fully ruled out. Veterinary professionals are encouraged to examine the genital area of dogs entering the UK from regions where TVT is endemic.

Keywords: Canine Transmissible Venereal Tumour (TVT), Imported Dogs, Epidemiology Veterinary Diagnostic Records

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Introduction

Canine transmissible venereal tumour (TVT) is a transmissible cancer of dogs [1–4]. Spread occurs when viable tumour cells are physically implanted from one dog onto another, most commonly during mating when damaged mucosa comes into contact with an infected animal [4]. Alternative routes—such as licking, sniffing, and birth—have also been described, classifying TVT as a naturally occurring, transmissible allograft [4–7].

TVT is considered the most ancient and globally distributed cancer known, with origins dated to around 11,000 years ago [8,9]. Only living tumour cells can transmit the disease—neither dead cells nor filtrates can initiate infection—demonstrating the contagious nature of the tumour itself [4,6,10]. Genomic similarities among tumours worldwide support descent from a single ancestral clone [6,8].

Normal canine cells contain 78 chromosomes, whereas TVT cells possess a highly altered karyotype with 58–59 chromosomes [11,12]. Although classified as a round cell tumour, presumed to originate from a histiocytic lineage [13,14], its original cell type has not been definitively established.

Lesions are usually located on the external genital region of males and females, but may also occur in cutaneous, nasal, or oral tissues [15–17]. Tumours can vary widely in size and frequently appear as friable, cauliflower-like masses that are often ulcerated or inflamed. Local tissue infiltration is common, while distant metastasis is uncommon and mainly observed in young or immunosuppressed animals [5].

As an allografted tumour, TVT should theoretically be eliminated by a competent immune system, similar to rejection of transplanted tissue in the absence of immunosuppression. In naïve adult dogs, implanted TVT cells typically proliferate for 2–6 months. During this period, extremely low major histocompatibility complex (MHC) expression appears to facilitate immune evasion [18–21]. After this growth phase, many tumours stop enlarging or regress. Although the mechanisms behind tumour establishment and the transition to regression remain unclear, increased MHC expression and a strengthening immune response are features of the regression stage [18–21]. These immune-driven changes are thought to shape the tumour's natural course, explaining why TVT seldom causes death and instead persists in populations through transmission during phases of immune escape [6].

Spontaneous regression has been observed experimentally [22], but the natural progression in field conditions is poorly defined; therefore, spontaneous cure should not be assumed. To prevent ongoing transmission and address welfare concerns, most pets are treated. Weekly vincristine therapy is the standard approach and generally results in clinical resolution within 3–5 weeks [23–26]. Radiotherapy has also shown success in resistant cases [27].

Globally, TVT is widespread and has been reported across all inhabited continents [28,29]. It is commonly associated with unmanaged or roaming dog populations where uncontrolled breeding occurs [28]. The tumour is more frequent in tropical and subtropical areas and is rare in North America and northern or central Europe due to effective stray-dog control [28]. Within the UK, TVT is not endemic, although sporadic cases have been noted in imported dogs.

Diagnostic laboratory records represent a substantial source of data for studying cancer occurrence and are valuable for establishing tumour registries. Such registries support surveillance of cancer trends and help evaluate the success of control strategies [30,31]. The Small Animal Veterinary Surveillance Network (SAVSNET) collects clinical records from veterinary practices as well as EPRs from diagnostic laboratories, supporting multiple functions including infectious disease monitoring [32,33] and broader surveillance activities [34]. Because the diagnostic dataset includes EPRs from most UK commercial laboratories, it provides a robust resource for assessing TVT within the UK.

Due to limited understanding of TVT in the UK and the possibility—though relatively low—that imported or returning dogs could allow the disease to become established, the objective of this study was to describe confirmed TVT cases diagnosed in the UK, including incidence, neuter status, spatial distribution, and documented country of origin.

Materials and Methods

This study was designed as a retrospective cohort analysis. The dataset was assembled by searching cytology and histopathology submissions from four commercial UK laboratories between 29 September 2010 and 30 October 2019 (inclusive). These records were anonymised and contributed voluntarily to SAVSNET, which operates under ethical approval from the University of Liverpool research ethics committee (RETH0000964).

To locate potential cases, digital queries using the keywords "venereal" or "TVT" were applied. All EPRs flagged by this search were then manually reviewed by a single specialist (DG). Inclusion required a confirmed TVT diagnosis based on cytological and/or histological evaluation. Records were excluded if they involved a species other than dogs, lacked histology or cytology results, produced a diagnosis other than TVT, or if TVT was suspected but additional tests (e.g., immunohistochemistry) were recommended without accompanying evidence that they had been performed.

For confirmed cases, available patient variables were collected, including signalment (age, breed, sex, neuter status), submission date (used instead of diagnosis date due to inconsistent availability), lesion site, diagnostic method (cytology, histology or both), and geographic information. Details on travel history or country of origin were also extracted if present.

Data were exported into a Microsoft Excel spreadsheet, cleaned by harmonising terminology (e.g., "dog" vs "canine"), and duplicates were removed using the laboratory accession number (for instance, when a single case had both cytology and histology under the same number). Descriptive statistics were then generated. A Mann–Kendall trend analysis was carried out using the trend R package (version 4.0.3) to assess the incidence of TVT

per 10,000 cytology or histopathology submissions over the study timeframe. A filled-map visualisation displaying UK administrative areas with TVT diagnoses was produced using Microsoft Excel for Mac (Version 16.45).

A second Mann–Kendall test was conducted to evaluate whether an apparent rise in case counts could be attributed to increased overall laboratory submissions or expanded market coverage by participating laboratories. Yearly TVT incidence per 10,000 total cytology or histology submissions was calculated, with 95% confidence intervals. These intervals for annual proportional incidence were determined using the exact Clopper–Pearson method via the prevalence package in R [35]. A significance threshold of $p < 0.05$ was applied.

Results

The initial dataset included 182 submissions, comprising 81 cytology and 101 histology samples. Of these, 45 were excluded because the findings indicated a round cell tumour but did not provide a definitive diagnosis, often due to recommended further testing that lacked documented follow-up. Another 56 records were removed because they represented alternative conditions, and 10 were excluded for being non-diagnostic.

Seventy-one cases satisfied the inclusion criteria. Thirteen were diagnosed by cytology (18%) and 58 by histology (81%). Only five cases had both cytology and histology performed, and none showed conflicting results. Mixed-breed dogs accounted for most cases (47, 66%). Other identified breeds included Border Collie (n = 2), Staffordshire Bull Terrier (n = 2), Labrador Retriever (n = 1), Golden Retriever (n = 1), Chihuahua (n = 1), English Setter (n = 1), Newfoundland (n = 1), and Old English Sheepdog (n = 1). Fourteen dogs had no breed recorded. Regarding reproductive status, 25 (35%) were neutered females, 27 (38%) neutered males, eight (11%) entire males, and eight (11%) entire females; sex was unreported in three cases. Missing age data prevented meaningful age-related analysis.

Most lesions occurred on the genital tract. Among 33 female dogs, 23 (69.7%) involved the vagina and seven (21.2%) the vulva. For 35 male dogs, lesions were reported on the penis in 18 cases (51.4%) and on the prepuce in 14 cases (40.0%). Neuter status did not substantially affect lesion distribution. Less frequent sites included the lip, perineum and a lymph node (one case each). Lesion site was absent from six records. A single tumour was documented in 47 of 71 cases (66%). Eight dogs (11%) had multiple lesions, including the one with lymph node involvement; the referring veterinarian had mentioned “multiple skin lesions,” though these were not sampled, and primary nodal TVT would be considered highly improbable. Lesion number was unreported for 16 dogs (22%). Because lesion counts relied on information supplied on the submission form rather than clinical examination, it is possible that some dogs recorded with a solitary lesion actually had multiple.

Information on importation or country of origin was available for 36 of the 71 cases (50.7%), with most originating from Romania (29/36, 81.0%). Other listed origins included Serbia (2), Spain (1), China (1), Greece (1) and Gambia (1). One imported dog lacked a specified country.

Using the postcode of the submitting practice, most UK cases were located in England (65/71, 91.5%). Four were reported from Scotland, one from Wales and one from Northern Ireland; one case lacked location data. Cases were dispersed throughout England **(Figure 1)**, with the highest concentration in the south: 26 in the South East and seven in the South West. Additional reports included 12 in the East Midlands, three in the West Midlands, six in the East of England and three in Yorkshire and the Humber. In northern regions, six were seen in the North West and one in the North East.

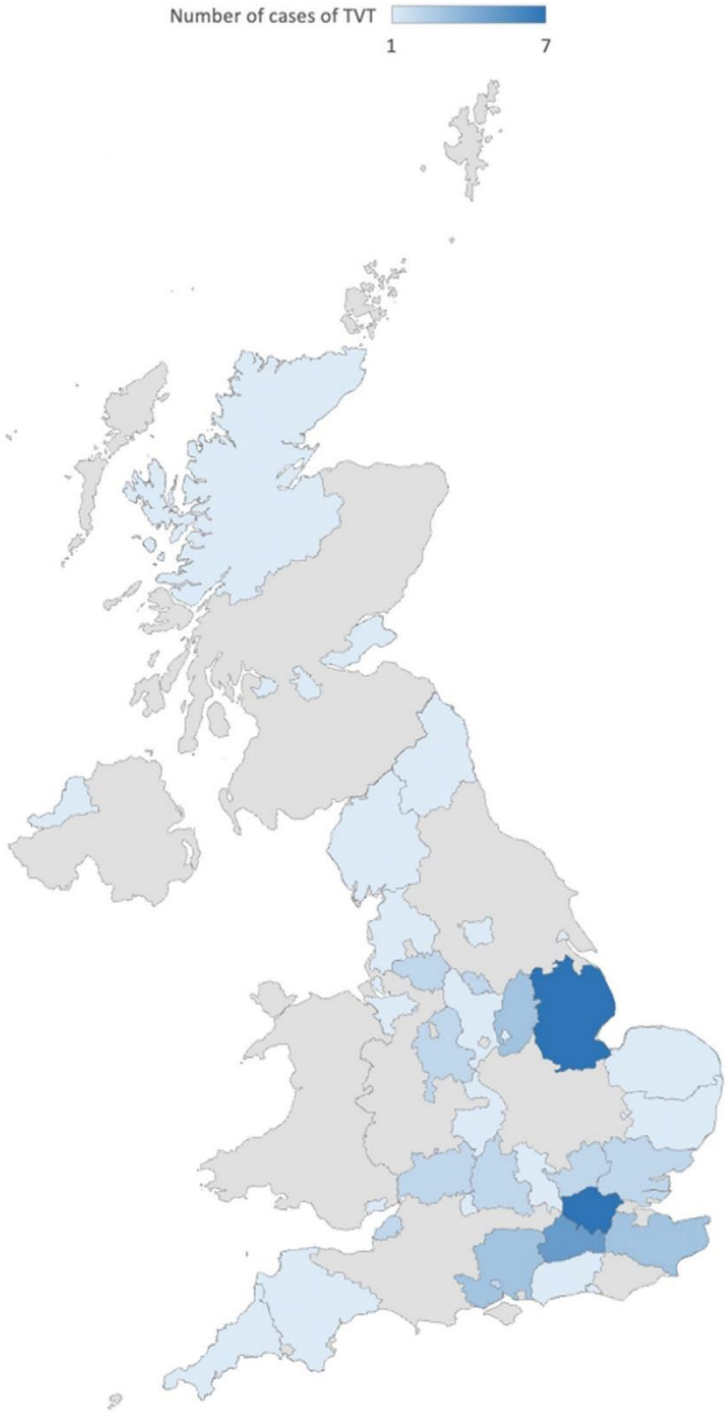

Figure 1. Geographical distribution of transmissible venereal tumour (TVT) cases reported by veterinary practices across the UK. Darker blue areas denote higher case counts, while grey regions had no identified cases. Some distortion in this map is possible due to variations in local population densities and the client base served by each laboratory

Although the overall case count stayed small, the rate at which TVT was detected rose over the study period **(Figure 2)**. Very few diagnoses were recorded before 2014, after which numbers showed a steady upward pattern.

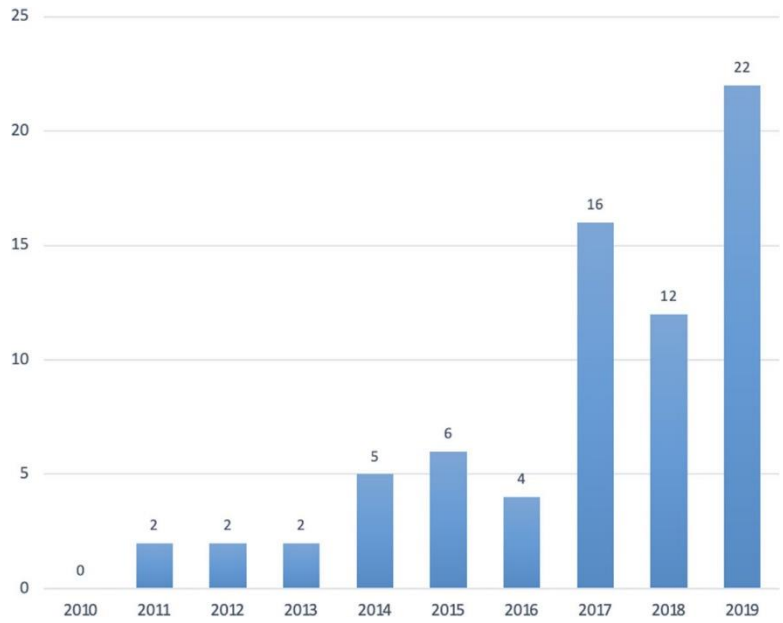

Figure 2. Annual totals of transmissible venereal tumour (TVT) diagnoses submitted to the participating UK laboratories

A Mann–Kendall trend analysis was used to evaluate TVT diagnoses per 10,000 cytology or histopathology submissions, with 95% confidence intervals, across the same timeframe **(Figure 3)**. The analysis demonstrated a significant positive trend ($z = 2.78$, $p = 0.005$), indicating that TVT incidence has been rising.

Figure 3. Annual incidence of transmissible venereal tumour (TVT) per 10,000 cytology and histology submissions (blue curve) with 95% confidence intervals (blue shading)

Discussion

TVT is a distinctive transmissible neoplasm of dogs spread through direct implantation of tumour cells, most often during mating. Although older literature documents its presence in the UK, it is not thought to be enzootic at present, likely due to widespread neutering practices and the relatively low number of stray or feral dogs [4, 28, 36]. Countries with substantial free-roaming dog populations, warmer climates and lower GDP per capita tend to report higher TVT prevalence, making it difficult to isolate the role of climate alone in disease distribution [4, 28]. The present work shows that TVT remains uncommon in the UK; however, the number of diagnoses increased during the years examined. Most cases were identified in England, which may reflect participation bias since all contributing laboratories were based there, as well as England's larger human and consequently larger canine population [37].

As anticipated, most tumours occurred on the external genitalia. Because this analysis relied solely on laboratory submissions, it is unclear whether additional lesions existed but were not sampled. This point is particularly pertinent for the dog with a lymph node tumour; having no detectable genital, nasal or cutaneous lesion would be atypical. It is presumed that another lesion was present and that the lymph node represented metastatic spread, but no evidence of another sampled site was available.

A substantial proportion of affected dogs were listed as imported. It is plausible that many of the remaining cases also involved imported animals, yet the completeness of origin data depends on what the submitting veterinarian included on the form and what was subsequently entered into the EPR. Therefore, these data cannot definitively rule out local infection or transmission. Accurate documentation of import status and country of origin on clinical records and laboratory submissions would greatly support surveillance of diseases considered non-enzootic and enable more confident identification of potential local circulation.

In recent years, rehoming dogs from international rescue groups has become increasingly popular among UK residents [38]. Evidence suggests that many of these animals are brought into the UK inappropriately under the EU Pet Travel Scheme (PETS; EU Regulation 576/2013), which applies only to non-commercial movement of pets travelling with their owners [38]. Dogs transported for commercial purposes—including rehoming and changes of ownership—should instead enter under the stricter Balai Directive (EU Regulation 92/65/ECC) [38]. When animals bypass the Balai requirements, including pre-export health checks, opportunities to identify conditions such as TVT before entry into the UK may be missed.

Against this backdrop of inconsistent import compliance, it is notable that UK TVT diagnoses have climbed over the past decade. Among dogs with documented origin in the EPR, 80% were from Romania. TVT is endemic in Romania, with a prevalence estimated at 5%–10% in recent research, associated with large stray dog populations and low neutering rates [29]. Data from the Animal and Plant Health Agency (APHA) indicate that 39,998 dogs entered the UK under the Balai Directive in 2017 [39], with 15,556 of these (38%) originating from Romania [40]. APHA reports no Romanian dogs being imported under Balai in 2013 [41], rising to 15,556 in 2017 [40], making Romania the leading source of imported dogs. The predominance of Romanian cases, therefore, reflects both high TVT prevalence and high import volume. Dogs from other high-prevalence countries likely pose similar per-dog risk for introducing TVT.

In 2017, 287,016 dogs entered the UK under PETS [39]. Because APHA does not track the country of origin for PETS arrivals [42], and because the Balai Directive is frequently not applied as intended, the true number of rescue dogs and puppies brought into the UK remains uncertain. This gap limits the UK's preparedness to monitor or prevent the introduction of non-enzootic diseases such as TVT.

The factors contributing to the rising number of dogs brought into the UK appear to involve both the eased requirements of the PETS travel scheme introduced in 2012 [43] and legislation enacted in Romania in 2013 that permits euthanasia of unclaimed stray dogs after 2 weeks [38]. This prompted the establishment of several UK-based rescue organisations, many of which began operating in or after 2014 in response to that policy. With the continued growth in imported dog numbers [38, 40–42], it is reasonable to assume that the likelihood of bringing in non-enzootic conditions such as TVT has also risen, generating heightened concern within the veterinary sector regarding the introduction of foreign diseases [38, 44–51]. This concern is amplified by recent changes to PETS that removed compulsory tick treatments, increasing the possibility that non-native ticks and tick-borne pathogens could become established in the UK. Indeed, imported rescue dogs have recently been diagnosed with leishmaniosis, babesiosis and Hepatozoon canis, with some reports confirming local onward transmission [46, 50, 52–55]. Because exposure risks for infectious diseases vary by country, tailoring surveillance and import requirements according to regional risk may be justified.

The introduction of non-enzootic parasites and pathogens through dog movement has been documented in several other nations as well; examples include the arrival and subsequent establishment of Dirofilaria repens [56] and, more recently, Dirofilaria immitis in Austria [56, 57], the importing of leishmaniasis into Canada [58], and cases identified in multiple northern European countries where it is not endemic [59]. Although comparable reports involving TVT importation into other non-enzootic regions are unavailable, the scenario is plausible, and thorough clinical examination of imported dogs is advisable.

A notable finding is that most affected dogs in this study were listed as neutered. Since transmission of TVT mainly occurs during mating [4] and nearly all described lesions were located on the genitalia, it is highly likely that these dogs were intact at the time of infection and neutered either shortly before or soon after entering the UK. The risk of sustained local transmission chains is considered low because many imported dogs are neutered

on or near arrival [38] and the UK has high neutering rates overall, reducing the number of local dogs involved in mating. Nonetheless, local spread cannot be entirely ruled out, as almost one quarter of dogs were recorded as entire at diagnosis.

This research highlights a novel use of an EPR-based tumour registry to track temporal changes in an uncommon transmissible cancer. One issue to consider is whether diagnostic standards may have shifted over time. In this dataset, the proportion of reports mentioning TVT without confirming it broadly paralleled the total number of TVT diagnoses each year, suggesting that changes in pathologists' diagnostic thresholds are unlikely to explain the observed rise.

Because of the inherent constraints of laboratory datasets, information regarding the timing of neutering relative to importation, the interval between entry into the UK and veterinary presentation (which may affect transmission likelihood), and details relating to treatment or clinical outcome were unavailable. However, as SAVSNET also collects extensive primary-care data, future research could explore these aspects further.

This study has several limitations. Its retrospective design and reliance on EPRs introduce inherent constraints. Case numbers are probably underestimates, as many reports lacked definitive diagnoses and historical tissue blocks were no longer accessible for reassessment. Additionally, the included pathology data do not represent all laboratory submissions undertaken by UK veterinarians. Because spontaneous regression can occur, not all tumours will have been sampled, and among those sampled, not all will have been submitted for pathological evaluation.

The Mann–Kendall test is intended to identify monotonic trends and does not adjust for potential seasonal effects. Given that the present analysis was conducted using annual data, this is unlikely to have significantly influenced results. While multiple laboratories contributed data, the small number of cases meant that we did not attempt to model potential clustering by laboratory, so differences in diagnostic practices cannot be entirely excluded.

Another source of bias arises from the need to remove a considerable number of cases without definitive TVT diagnoses (often labelled as "round cell tumour"). Pathologists may also have been less likely to conclusively diagnose TVT in non-genital samples, especially when no travel history was documented.

Overall, this study illustrates that curated EPR datasets such as those within SAVSNET can serve as valuable tools for monitoring disease and cancer trends and can complement existing veterinary surveillance systems [60–62]. Our findings indicate that TVT diagnoses are increasing within the UK, with a strong apparent link to imported dogs, particularly those originating from Romania. Based on these observations, veterinarians should perform careful genital examinations of all imported dogs at their first visit and recommend neutering either before importation or promptly after arrival to reduce the risk of onward spread. Moreover, because local transmission cannot be ruled out, TVT should remain a differential diagnosis for any genital mass identified in dogs within the UK.

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