Maranda Keaton

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Canine Transmissible Venereal Tumor and breed relatedness

Evolution Final Project

**Abstract**

Canine Transmissible Venereal Tumor is a serious cancer that is transmitted from canine to canine. As one of the few cancers that acts in this behavior, it has astonished people for years. Some breeds of canines are thought to show a higher occurrence rate than other breeds due to their size and roaming tendencies. Data on CTVT was collected from papers during 2012-2018 and organized by breed that were positive for the cancer. R studio was then used in order to compare data of all the canines in order to compare occurrences to each breed. Cross Breeds and Spitz showed the two largest occurrences from the data collected. When Cross Breeds are exempt from the data, large-medium breed canines have 57.6% occurrence rate among these canines. After data analysis, it is possible that some breeds are have a higher occurrence although breed size is not a key factor.

**Introduction**

Canine Transmissible Venereal Tumor (CTVT) or “Sticklers Sarcoma” is a sarcoma cancer that is found within the domestic dog population. It has been found to affect a large group of the canine population and is considered endemic in 90 countries across the globe (Strakova and Murchison 2014). Although mainly affecting domestic canines, it can also affect others of the canidfamily such as wolves (vonHoldt and Ostrander 2006; Stockmann et al. 2011). Originally characterized more than 130 years ago, this cancer acts like a parasite as is jumps between canine via contact with the infected area that contains live cells (Murgia et al. 2006). This can include sniffing, mating, licking, or brushing against the affected area (Papazoglou et al. 2001). Normally, it would affect the genital and extragenital areas but can also be found within subcutaneous tissues such as the nasal cavity, oral cavity, and any other place that might come into contact with the live cancer cells (Stockmann et al. 2011). Something that is strange is that this type of cancer does not transfer to other species though; so it is only found within the canine population. In addition, there are only a few other known cancers that act like this and are found in Tasmanian Devils and Syrian Hamsters (Ganguly et al. 2016).

Three lines of observation can been seen with this cancer; CTVT cannot be contracted unless via live cells, it has an aneuploid karyotype but has similar markers from different geographic regions, and lastly LINE-1 has been found in all CTVT tumors (Murgia et al. 2006). This LINE-1 element is not found naturally in a canine an upstream of the *c-myc* gene which might give evidence that this gene has been obtained over time (Murgia et al. 2006; Rebbeck et al. 2009). Although, this type of cancer has not originated many times, if any at all. It is thought this lineage has originally arose from a domestic dog or wolf due to the properties of the LINE-1 element (Rebbeck et al. 2009; Stockmann et al. 2011). In addition, if has been found that the *TP53* gene, which helps to suppress tumor, mutations have been seen in CTVT cases (Stockmann et al. 2011). The loss of the p53 protein has also been lost in canines with CTVT; whether through mutations, deletions, or pathways disruption is unknown(Murgia et al. 2006; Stockmann et al. 2011).

Canines that are strays and unaltered females are highly at risk as well as canines that are left outside unsupervised (Ganguly et al. 2016). Unsupervised canines can have a high as a 96% prevalence rate due to them being able to roam or other dogs come into the population that they are occupying (Ganguly et al. 2016). This is due to these roaming animals being able to come in and out of different populations. So if a roaming stray is infected with CTVT, it may come into another canines population and spread it throughout due to migration of this stray.

Because of this, some breeds are more prone to coming into contact with CTVT. For instance, breeds such as German Shepherds have been breed to be working dogs. These types of breeds naturally have an instinct to herd and roam. An increase in roaming could be linked to the increase of development. This study will look at the occurrences of reported cases of CTVT in different breeds. Development of CTVT within the canine population is significantly different between breeds and will increase in frequency due to the tendencies of larger breeds to roam.

**Methods**

***Collection of Data***

Data for positive CTVT canines was collected from published papers between the years of 2012-2018 (Varughese et al. 2012; Srivastava et al. 2014; Adrian et al. 2015; Islam et al. 2017; Yadav et al. 2018). 162 cases of CTVT were included in the study. Most cases were located in India, but there were also cases included from the United Stated, Korea, and Bangladesh. These were then placed in an excel sheet which the breed of the animal was noted as well as any additional information that might be useful such as sex, age, and area where the case was reported. Canine breeds included in the data set were Cross Breeds, Spitz, Labrador Retrievers, German Shepard, Doberman, Great Dane, Yorkshire Terrier, and Dalmatian (Figure 1). Cross Breeds are considered any canine that is not just one breed; this includes designer dogs like Golden Doodles but is mostly noted as stray dogs.

***Coding the Data***

To start, R coding software was used in order to graph the excel data. R-package “TidyVerse” was used to compare the canine breeds and the amount of positive cases that each one had (Figure 1). These were plotted to see which breed had the largest number of reported cases. Percentages of each breed was calculated by hand and added to the graph. Secondly, a cladogram was created in order to visualize the relatedness of the canine breeds listed (Figure 2). This was created using various software packages within the R program. Data for the cladogram was read into R on all domestic canines. This data was read in via “ape” package into the R-studio and data for this set was collected via GitHub. Figure 2 can be used in order to see how all of these breeds are related and if their relatedness could increase their susceptibility to CTVT.

**Results:**

A screenshot of a cell phone

Description automatically generated

Figure 1: Comparison of breed to amount the positive CTVT cases reported for the breed. These cases were collected from the years of 2012-2019 from published research articles. 162 canines were included in the study. 70 were cross breeds, 39 were Spitz, 21 were German Shepard, 16 were Labrador Retrievers, 13 were Doberman, 2 were Great Dane, 1 was Yorkshire Terrier, and 1 was Dalmatian.

162 canines were included in the study. 70 were cross breeds, 39 were Spitz, 21 were German Shepard, 16 were Labrador Retrievers, 13 were Doberman, 2 were Great Dane, 1 was Yorkshire Terrier, and 1 was Dalmatian. After data analysis, cross breed canines were found to be the most likely canines to be affected by the cancer by having a 43.2% occurrence of positive cases (Figure 1). This could be related to the increased frequency that crossbreed canines are normally stray dogs that are found freely roaming. Thus, they cross between different populations as they roam and have a higher likelihood of being infected. Spitz also showed a high frequency of reported cases at 23.5% (Figure 1). This breed of dog was originally bred for hunting purposes and are known to roam frequently (Bell et al. 2012). German Shephard, Doberman, and Labradors were also well represented in the analysis (Figure 1). German Shepherds made us 12.9% of the positive cases, while Labradors made up 9.9% and Doberman made up 8.0% (Figure 1). Great Dane, Yorkshire Terrier, and Dalmatian were under-represented. Great Dane made up 1.2% positive cases, Yorkshire Terrier made up 0.6% positive cases, and Dalmatian made up 0.6% positive cases (Figure 1).

Large-medium size dogs accounted for approximately 57.6% of positive cases (Figure 1; Bell et al. 2012). Cross Breeds were removed from this statistic due to these having a large varying weight range. Although when Cross Breeds are accounted for, it is hard to observe if size could be a variable due to unknown weight ranges.

**Discussion**

All of the breeds in this study differ in how they are related to one another (Figure 2). So, relatedness is most likely not a factor occurrences of CTVT. Although, most of these canines have a history of being a breed that is bred for a “working job”, possibly making it more likely that these breeds will come into contact with the CTVT cancer due to their possible roaming habits. While the remaining of the group has a history of being “designer” or “show dogs” that are not likely to be left to roam and instead sheltered closely by humans (Bell et al. 2012). In particular, Spitz made up a large number of the positive cases which could be related to their hunting purposes inherited from their ancestors. Interesting enough, they are considered a smaller breed canine (Bell et al. 2012).

This study has shown that canines that have natural roaming instincts are more likely to affected by this cancer. Although, there does not seem to be correlation between breed size and the occurrence of CTVT. More information could lead to development of a more accurate study. Increasing the number of individuals that were looked at within the study could dramatically change the percentages of positive cases. In addition, it could spread new light as to what breeds are more prone. It also might be beneficial to include a large period in which these cases were looked at. This could improve quality of the results as well. Another topic that could be interesting to look into is what number of these breeds are stray canines that have been taken in by humans. Seeing these numbers might show that over all strays are more prone to this cancer since they are not supervised by humans. Further evaluation must be done in order to conclude these statements and observations.

There are many ways that someone can prevent this cancer from spreading between populations. In particular, supervising your canine when roaming freely can reduce their occurrence with this cancer. Only 4% of canines that are well supervise were diagnosed in 2016 with CTVT (Ganguly et al. 2016). Tumors are seen more commonly in canines that are of reproductive age but spaying and neutering your canine could reduce their risk (Günay Uçmak et al. 2019).



Figure 2: Cladogram of different breeds of domestic canines. This cladogram is based on relatedness of each breed.

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