**RABIES SURVEILLANCE IN ALLEGHENY COUNTY, 2015-2016**

by

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Submitted to the Graduate Faculty of

the Department of Epidemiology of the

Graduate School of Public Health in partial fulfillment

of the requirements for the degree of

Master of Public Health

University of Pittsburgh

2017

UNIVERSITY OF PITTSBURGH

GRADUATE SCHOOL OF PUBLIC HEALTH

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on

December 14, 2017

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**ABSTRACT**

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**Background:**

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**RABIES SURVEILLANCE IN ALLEGHENY COUNTY, 2015-2016**

Daniel Edward Seresin, MPH

University of Pittsburgh, 2017

Rabies is a virtually incurable and almost universally fatal disease in humans. The Allegheny County Health Department (ACHD) maintains an animal bite surveillance program as part of rabies prevention efforts. ACHD monitors the health of both the victim and animal so that victims can receive rabies post-exposure prophylaxis (PEP) if they are at risk for contracting rabies, which must be administered before symptoms develop. The purpose of this study was to describe of the burden of animal bites and rabies in Allegheny County and to determine if physicians were following the treatment protocols recommended by ACHD.

**Methods:**

This study included all data on bites collected by ACHD for 2 years (2015-2016). This included n = 3722 total bites after bites were removed for being due to animals that do not carry rabies (n=15). We eliminated duplicates from the records. We examined frequencies and distributions of characteristics of the bites and victims. All statistical analyses were conducted using SAS v9.4. Mapping of bite locations was performed using ArcMap 10.5.1.

**Results:**

There were 3722 total bites reported to ACHD in 2015-2016, with dogs (72.6%) and cats (22.5%) and bats (1.6%) responsible for the vast majority of reported bites. Of all the bites, 20 resulted in a confirmed exposure to an animal that tested positive for rabies, all of which were due to wild animals or feral cats. One person exposed to rabies refused treatment with PEP, but did not develop rabies. An additional 172 persons received PEP primarily due to being exposed to an animal where rabies status could not positively be confirmed as positive for negative, although 27 of these 172 persons received PEP unnecessarily.

**Conclusions:**

The animal bite reporting system remains successful in preventing human cases of rabies in Allegheny County, which constitutes a significant success for public health. The primary vector for human exposure in Allegheny County is from wild animals, suggesting that stronger communication on the risks posed by approaching wild animals may be beneficial. Physicians in Allegheny County are prescribing their patients PEP too often when there is no risk of rabies, causing undue stress and financial burden.

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# Background

## Disease Summary

Human rabies is a disease that poses near certain risk of fatality if an exposed individual is not vaccinated shortly after exposure. Nearly 55,000 individuals die worldwide each year from rabies, however, only two to three of those reported deaths occur in the United States where prophylactic vaccination is standard in suspected exposures.1,2 Worldwide, dogs are the primary source of transmission of rabies to humans, but dog rabies is primarily an issue in less developed countries. In countries where rabies vaccination of dogs is standard practice, bats are the primary vector. Other carnivorous mammals including raccoons, skunks, and coyotes are secondary reservoirs of rabies virus in developed countries.2

Rabies is a viral disease caused by the rabies virus of the *Lyssavirus* genus. Rabies is the 11th most deadly infectious disease worldwide and has the highest case fatality rate of any known infectious disease.3 Rabies is typically transmitted via saliva of infected animals through a bite, but can also be transmitted through exposure of infected saliva to an open wound or scratch, and in rare cases has been transmitted by transplantation of rabies-infected organs. The typical incubation period is 30-90 days, but bites to the head or neck generally have shorter incubation periods. Rarely, the incubation of rabies can extend for several years.3 The activity of the virus during the incubation period is not well understood. It is believed that there is an extended delay period before the virus begins moving throughout the body, which possibly occurs through infection of muscle fibers to transmit the virus into the central nervous system (CNS). It is clearer, however, that the virus localizes within the brain once it transmits itself into the CNS, which leads neuronal cell dysfunction, the root cause of the neurological symptoms associated with rabies.4

The incubation period is followed by the prodromal period, where the earliest symptoms start to develop. By this time, the virus has infected most of the CNS, and early symptoms are usually hard to directly link to rabies: flu-like symptoms, fever, and localized pain at the bite location. The disease will eventually progress into a more severe neurological disease, which broadly speaking follows two courses: “furious” and “paralytic”. “Furious” disease progression is estimated as occurring in around 2/3 of human rabies cases, and “paralytic” disease in 1/3.5 Furious rabies is characterized by initially retained consciousness with spasms, agitation, confusion, salivation, irritability, aerophobia, and hydrophobia, eventually progressing into coma and death, and generally is the more “classical” presentation of rabies in humans. In contrast, paralytic rabies is associated with partial facial paralysis, limb numbness/weakness (at bitten limb), persistent fever, muscle contraction, and bladder dysfunction, which proceeds to coma and death. Paralytic rabies is generally harder to diagnose properly, with the best evidence of infection generally being the conjunction of most of the unique symptoms and retained sensory function in areas other than the bitten limb and face. Death in rabies cases ultimately results from cardiac arrhythmia during the coma leading to circulatory insufficiency.2 Death occurs in nearly all cases once symptoms develop. There are only six documented cases of rabies which have not resulted in death, only two of which did not involve survival with serious neurologic damage.1

## Rabies Treatment

Given the near 100% case fatality rate for symptomatic rabies, early vaccination is vital to prevent clinical disease. There are two main approaches to vaccination: pre-exposure prophylaxis and post-exposure prophylaxis. Pre-exposure prophylaxis is mainly indicated in people who are at high risk of exposure to rabid animals: veterinarians, researchers, clinicians, animal control officers, cave explorers, and bat handlers. Travelers to regions with higher rates of rabies (especially in dogs) or to wilderness areas should also get pre-exposure prophylaxis. Pre-exposure prophylaxis involves a three dose vaccination course that occurs on day 0, day 7, and day 21 or day 28. Post-exposure prophylaxis generally involves two parts: rabies vaccination and administration of human rabies immunoglobulin (HRIG). This treatment takes advantage of the long incubation period of rabies to inoculate exposed persons prior to virus dissemination throughout the body and symptom development. Treatment involves initial wound cleansing and injection of HRIG directly into the site of the wound in an attempt to neutralize the virus before it spreads beyond the site of the initial wound, in conjunction with an intramuscular rabies vaccination, preferably at a site distant from the wound site. This is followed by additional doses of the rabies vaccine on days 3, 7, and 14.1,6 It is vital that post-exposure prophylaxis is completed in a timely fashion following rabies exposure; post-exposure prophylaxis has been demonstrated to be completely ineffective in treatment of symptomatic rabies, and may even result in faster disease progression in symptomatic individuals.7

Prior to 2004, there were no documented cases of survival of symptomatic rabies, but an experimental therapy developed at the Children’s Hospital of Milwaukee (known as the “Milwaukee Protocol”) has demonstrated some limited effectiveness in preventing death in symptomatic individuals, with it producing an estimated 9% survival in an intention to treat analysis.7 The “Milwaukee Protocol” involves coma induction using intravenous ketamine and midazolam in absence of rabies vaccination (due to the aforementioned risk of faster disease progression).8 The comatose patient is administered the antiviral drugs ribavirin and amantadine in combination during the coma to help combat the rabies virus while the body develops an immune response to the virus. The length of this treatment can be quite long: the first patient treated this way was kept under treatment with this drug combination for 2-3 weeks, kept in isolation for 31 days (until virus was undetectable), and was released from the hospital after 76 days. She recovered significantly, but was left with permanent neurologic damage, including decreased motor function.8

## Rabies in the United States

In the United States, the vast majority of reported cases of rabies in animals come from wild animals. Raccoons, skunks, foxes, bats, and mongooses (only in Puerto Rico) are the main reservoirs of viral rabies variants. Other than bats, which are found with rabies throughout the entire continental United States, raccoon rabies is primarily in the eastern United States, skunk rabies in the Midwest and California, fox rabies in the Southwest and Alaska. In 2014, 5,588 (92.6%) confirmed cases of rabies in animals were in wild animals, 30.2% of which were in raccoons, 29.1% in bats, and 26.32% in foxes.9 Domestic animals were a relatively small portion of nationally reported rabies, primarily in cats and dogs. Dog rabies cases were primarily centered in the south-central US around Oklahoma and Texas, with 59 total cases reported. Cats are by far the most commonly reported domestic animal with rabies, making up 61% of all reported cases of domestic animal rabies.9 Pennsylvania led the United States in cat rabies, with 17.3% of all reported cases of cat rabies.9 In both cat and dogs, reported rabies almost universally presented in unvaccinated animals or animals lacking up-to-date vaccinations, with only one cat (out of all cats and dogs) reported with rabies despite up-to-date vaccination.9

Thanks to widespread vaccination, cats and dogs have successfully been eliminated as major reservoirs of rabies in the United States. As a result of this success, most subsequent public health efforts around rabies have primarily been passive surveillance that focused on identifying human exposures and ensuring treatment with post-exposure prophylaxis, rather than targeted efforts at reducing rabies in wildlife populations. In 2004, efforts began to shift towards prevention, with large-scale public health efforts of active surveillance initiated in order to characterize rabies in wildlife populations. The United States Department of Agriculture (USDA) has taken charge of this effort, which has aimed to reduce or eliminate rabies in the eastern United States from the raccoon population, which has been identified as the animal reservoir with the most reported cases of rabies. The USDA has begun to conduct mass vaccination of wild raccoon populations, with the hope that they can vaccinate to a large enough extent to generate herd immunity in the raccoon population and slowly eliminate raccoon rabies from the US.10

Vaccination occurs through combined efforts of the USDA, local health departments, and local wildlife management programs via use of oral rabies vaccination in the form of baits. Baits are typically a vaccine packet encased within fishmeal, intended to attract raccoons to eat them as a method of vaccinating large areas without directly having to interact with raccoons. Although oral rabies vaccination is primarily being used currently for raccoon rabies, it also has been demonstrated as an effective method for controlling rabies in skunks, coyotes, and foxes. A novel way of providing vaccination to bats remains elusive, and may limit the potential effectiveness of oral rabies vaccination, as the viral rabies variants present in carnivores in the United States may have originally been transmitted to them by bats before later mutating into novel viral variants.11 One study of cross-species transmission estimated that nearly half of reported cases of rabies in parts of the US primarily associated with raccoon-variant rabies were cases of raccoon variant rabies in non-raccoon species. This study also noted that cross-species transmission from bats into skunks and foxes had resulted in a sustained reservoir of bat rabies variants in those species within a part of northern Arizona.12 However, nearly $300 million is spent yearly on post-exposure prophylaxis, passive surveillance, lab testing, and other associated costs in the United States on rabies alone. Even with this expense, the oral rabies vaccination program results in a net expected savings.11 In Texas, an oral rabies vaccination program spent $26 million in 1995-2006 to eliminate fox and coyote rabies variants. Methods of estimating savings varied greatly, with estimates of savings across the entire period ranging between $89 million and $346 million, but even the most conservative estimate of $89 million constitutes significant savings in health costs.13

In humans, there were 37 reported cases of rabies in the United States between 2003 and 2015. Most (70%) of these cases originated in the United States, with bats (65%) and organ transplants (19%) as the main vectors infection within the United States.9 However, the burden of rabies on the medical system extends far beyond individuals who develop rabies. Estimates suggest post-exposure prophylaxis is given an estimated 20,000-40,000 times per year in the United States (the CDC does not directly report on post-exposure prophylaxis usage for rabies). This indicates that medical treatment of rabies extends far beyond what the number of cases of human rabies in the United States would suggest. 11,14

## Rabies Surveillance in Allegheny COunty

Health care providers are required by law to report all animal bites/scratches to the Allegheny County Health Department (ACHD). Reporting of animal bites to ACHD happens for one or more of the following reasons: the victim is an Allegheny County resident, the owner of the animal is an Allegheny County resident, the victim is treated at an Allegheny County medical facility, or the bite occurred in Allegheny County. After receiving a bite report, ACHD then contacts both the victim and owner of the involved animal (if applicable) to gather further information about the incident beyond what the medical professionals have submitted. If the bite is from a pet that is observable (that is, the victim or owner can monitor the health of the animal that was responsible for the incident), then ACHD issues a 10-day in-home quarantine. This quarantine requires the animal to be monitored for 10 days in the owner’s home and kept away from other animals (to prevent spread of rabies should it develop symptoms). Should the animal survive for 10 days, then there is sufficient evidence that the animal was not infected with rabies at the time of the bite, and thus there is no risk of the victim contracting rabies. This “quarantine” can be extended to stray cats or dogs as well; if a victim regularly sees a stray, they can check for its survival at 10 days past exposure to ensure there is no risk of contracting rabies. However, if it is a wild animal, it cannot be quarantined by this methodology as the period of infectiousness is variable and an appropriate length of quarantine/observation has not been established for these animals.

 If the animal dies within the 10 day quarantine period it is immediately tested for rabies. If the biting animal under observation tests positive for rabies, or if the biting animal is a wild animal that is not available for rabies testing, treatment of the victim with post-exposure prophylaxis (PEP) using human rabies immunoglobulin (HRIG) and human diploid cell rabies vaccine (HDCV) is indicated. If pets are euthanized due to aggressive behavior that resulted in a bite, or die within the quarantine period, the animal will be submitted to an ACHD lab for rabies testing before the victim is recommended to receive PEP. PEP then will only be indicated if a positive rabies test result is confirmed. ACHD staff monitor progress of the lab testing and then contact the victim to advise them on whether or not they should get treated with PEP. ACHD staff also check for up-to-date vaccinations on pets by contacting the appropriate veterinarians. ACHD staff also monitor progress of the PEP vaccine sequence for individuals who receive it to ensure they complete all the doses and get the doses on the correct dates.

The purpose of this report was to monitor the burden of injury due animal bites in Allegheny County, and to monitor the usage of different treatments for animal bites within the county. Given the financial and time burdens placed on individuals who get treated with PEP, the Allegheny County Health Department wanted to ensure that usage of the vaccine was only in cases where it was medically indicated, and monitored the exact circumstances that led to an individual being given PEP to identify how often it was prescribed when not medically necessary

# Methods

## Data Sources

Data was primarily derived from the “Animal Bite Report” forms submitted to the Allegheny County Health Department (ACHD) by local physicians. Data on these bite report forms were entered into an Oracle database by ACHD staff. For this analysis, all reports with date of bite in 2015 or 2016 were included. If bite date was missing, the date of the bite report was substituted for bite date during the analysis phase. Populations by zip code were derived from US Census 2015 American Community Survey population estimates, and these zip codes were using in mapping analyses.15 Bites occurring in zip codes that only partially lie within Allegheny County were excluded from mapping analysis.

## Population

The population used in this study involved persons who were the victim of an animal bite that was reported to the Allegheny County Health Department and occurred between January 1, 2015 and December 31, 2016. Bite reports generally were submitted to the Allegheny County for any combination of the following reasons: the bite victim was an Allegheny County resident, the bite victim was treated at an Allegheny County medical facility, the bite occurred in Allegheny County, or the animal was a pet whose owner resided within Allegheny County. Although address data was collected on both victims’ residence and location where bite occurred, the location data was not coded in a standardized way and specific addresses were often unavailable for bite location. As a result, the more complete and properly coded ZIP code of victim’s residence variable was used for location-based analyses.

## Variables

Bite reports include information on a large number of characteristics such as age, sex, address of home residence, medical facility of treatment, type of treatment received (antibiotics, rabies vaccine, tetanus shots), and type of injury received (bite, scratch, and where on the body the injury was). Information collected about the bite included date of bite occurrence, date bite reported to ACHD, bite address, species of responsible animal, and a brief description of what caused the bite to occur from a list of 26 different incident descriptions. Information gathered about the animal responsible for a bite included whether or not the animal was tested for rabies, if it tested positive for rabies, what breed it was (if a dog), whether it was previously vaccinated for rabies (if a pet), and home address of the animal’s owner (if a pet).

## Analysis

Data were then cleaned to eliminate duplicate entries. Duplicate entries were identified using a combination of victim’s name, bite date, and victim’s home address. Some reported bites involved non-mammals (including snakes and birds), which cannot contract rabies, and thus were excluded from further analysis. The data were then imported into SAS v9.4. Descriptive analysis was then performed in SAS, and graphs and tables for were generated in SAS and Microsoft Excel.

Information on frequency of bites by ZIP code of victim’s residence was gathered using SAS, with ZIP codes either partially or entirely outside of Allegheny County excluded from further analysis. These data were then entered into ArcMap v10.5.1, which was used to create maps of rates of bites per 100,000 population within Allegheny County by ZIP code.

# Results

As can be seen in Figure 1, there were 3722 total reported exposures (bites, scratches, etc.) in 2015 and 2016. There were 1912 total reported exposures in 2016, and 1810 in 2015 (Figure 1). In general, warmer months had a higher number of exposures, with April-August having more exposures than other months. In general, there seems to have been a similar or increased number of exposure in 2016 compared to 2015, other than in November and December. Note that 146 of these exposures originally had missing bite dates; these 146 bites were still included in Figure 1 by setting the bite date to be the same as the day the bite was reported to ACHD, which was available for all 146 of these bites.

Figure : Bite reports received by ACHD by month, 2015-2016

As can be seen in Table 1, bites suffered by Allegheny County residents or bites that occurred in Allegheny County to non-residents (the two main areas of interest for ACHD) made up 99.2% of all reported bites. The remaining 0.8% of bites, accounting for 29 total bites appeared solely because an individual was treated at an Allegheny County medical facility. The vast majority (94.5%) of the animal bite reports handled by ACHD directly involve residents of Allegheny County. The percentage of bites affecting residents was relatively similar in 2015 and 2016 (Figure 2).

Table : County of victim residence and county of occurrence for bites reported to ACHD, 2015-2016

|  |  |  |
| --- | --- | --- |
| **Bite Victim** | **County of Bite Occurrence** | **n (%)** |
| **Allegheny County Resident** | Allegheny County |  3496 (93.9) |
| Other county |  23 (0.6) |
| Total |  3519 (94.5) |
| **Non-resident** | Allegheny County |  174 (4.7) |
| Other county |  29 (0.8) |
| Total |  203 (5.5) |

Figure : Number of reported bites by county of residence, 2015-2016

As seen in Table 2, Dogs (72.6%) and cats (22.5%) combined for over 95% of all reported bites in Allegheny County in 2015-2016. Cats were classified as either pet or stray/feral; pet cats constituted 18.2% of all reported bites, and stray/feral cats constituted 4.3% of reported bites (Table 2). Numerous other species also were involved in reported bites, including raccoons and bats, which combined for about 2.2% of all reported bites, but together contributed 65% of confirmed rabies exposures (Table 2). Although only one bite was reported for both skunks and coyotes, both involved rabies positive animals (Table 2). Unknown/missing animals constituted 1.3% of all reports; either a person could not positively identify what type of animal bit them or no species information was provided (Table 2).

As can be seen in Table 2, 179 persons were bitten by an animal that was later tested for rabies by ACHD. These 179 persons constitute 4.8% of all bites reported to ACHD in 2015-2016. Of these 179 persons, 20 (11.2%) were exposed to an animal that tested positive for rabies. None of the animals that tested positive were pets; the 5 exposures to rabies positive cats all involved stray/feral cats (Table 2). Bats remain the main vector of human exposure to rabies; 50% of exposures involving a rabid animal involved a bat. Bats pose a relatively high risk of exposure to rabies; 17.2% (10/58) of all bat exposures involved a rabid bat (Table 2). Raccoons also pose a high risk, with 14.3% (3/21) of all raccoon exposures involving a rabid raccoon (Table 2). No dogs tested positive for rabies in 2015-2016 (Table 2).

Table : Species and rabies test results of animals listed on bites reported to ACHD, 2015-2016

|  |  |  |  |
| --- | --- | --- | --- |
| Species | Number of human exposures (%)  | Number of persons exposed to an animal tested for rabies (%) | Number of persons exposed to an animal testing positive for rabies (%) |
| Dog | 2701 (72.6) |  87 (48.6) |  0 (0.0) |
| Cat (total) |  838 (22.5) |  61 (34.1) |  5 (25.0) |
|  Pet  |  679 (18.2) |  37 (20.7) |  0 (0.0) |
|  Stray/Feral |  159 (4.3) |  24 (13.4) |  5 (25.0) |
| Bat |  58 (1.6) |  20 (11.2) | 10 (50.0) |
| Raccoon |  21 (0.6) |  6 (3.4) |  3 (15.0) |
| Mouse |  10 (0.2) |  0 (0.0) |  0 (0.0) |
| Ferret |  8 (0.2) |  2 (1.2) |  0 (0.0) |
| Squirrel |  7 (0.2) |  0 (0.0) |  0 (0.0) |
| Rat |  6 (0.2) |  0 (0.0) |  0 (0.0) |
| Groundhog |  4 (0.1) |  1 (0.6) |  0 (0.0) |
| Hamster |  3 (0.1) |  0 (0.0) |  0 (0.0) |
| Monkey |  3 (0.1) |  0 (0.0) |  0 (0.0) |
| Guinea Pig |  2 (0.1) |  0 (0.0) |  0 (0.0) |
| Chipmunk  |  2 (0.1) |  0 (0.0) |  0 (0.0) |
| Rabbit |  2 (0.1) |  0 (0.0) |  0 (0.0) |
| Coyote |  1 (<0.1) |  1 (0.6) |  1 (5.0)  |
| Fox |  1 (<0.1) |  0 (0.0) |  0 (0.0) |
| Horse |  1 (<0.1) |  0 (0.0) |  0 (0.0) |
| Opossum |  1 (<0.1) |  0 (0.0) |  0 (0.0) |
| Skunk |  1 (<0.1) |  1 (0.6) |  1 (5.0) |
| Unknown/Missing |  52 (1.3) |  0 (0.0) |  0 (0.0) |
| Total | 3722 (100.0) | 179 (100.0) | 20 (100.0) |

Females constituted 56% of all bite victims, while males constituted 41% of all bite victims. An additional 3% of bite victims had no reported information on sex (Results not shown).

The overall median age of exposed persons was 34 years, ranging from 1 year old to 100 years old. As seen in Figure 3, based on population rates of bites per 100,000 population (using 2015 US Census American Community Survey population estimates), children (14 years or less) and younger adults (20-34) were at highest risk for an animal bite.15

Figure : Rate of reported bites per 100,000 population by age group, 2015-2016

The majority (56.9%) of all injuries were to upper extremities (arms and hands) (Table 3). Lower extremities (legs and feet) were a distant second (16.7%), with face/head/neck shortly behind at 15.3% (Table 3). Injuries that were solely suffered on the trunk (chest, back, or other abdomen injuries) accounted for only 2.1% (Table 3). People who reported injuries to body parts in multiple categories constituted 4.2% of all reports, and 4.8% were missing detailed information on what body part(s) were injured (Table 3). Information about what type of wound, including whether the exposure was a bite, scratch, resulted in broken skin, or was a deep wound, was collected. Analysis of wound type was excluded from this analysis due to a large number of reports having incomplete data.

Table : Body part where victim reported receiving bite, scratch, or other exposure, 2015-2016

|  |  |
| --- | --- |
| **Body Part** | **n (%)** |
| Upper Extremity | 2117 (56.9) |
| Lower Extremity |  622 (16.7)  |
| Face/Head/Neck |  568 (15.3) |
| Trunk |  80 (2.1) |
| Multiple categories |  156 (4.2) |
| Missing |  179 (4.8) |

The bite report form used by ACHD asks physicians/preparers to supply information about the circumstances that resulted in an animal bite. The form has a list of categories (Table 4) which are used to describe the incident. The largest number of incidents falls under the “other” category (34.8%), which is a catch-all for any type of event that does not fall into the listed categories and allows the person completing the form to provide a more detailed description of what occurred. Examples of situations classified under other include cases where a pet’s owner told their pet to attack someone, or inadvertent scratches by a person’s pet cat. The most common reported events involve pet-related interactions.

Table : Reported causes of bites, 2015-2016

|  |  |
| --- | --- |
| Incident Type | n (%) |
| Playing with the animal  |  306 (8.2) |
| The animal got spooked |  296 (8.0) |
| Breaking up a fight |  293 (7.9) |
| Trying to pet the animal |  202 (5.4) |
| Walking on the road |  126 (3.4) |
| Performing a medical procedure |  110 (3.0) |
| Trying to capture the animal |  87 (2.3) |
| At a community area and animal came up and bit the victim |  84 (2.3) |
| Entering the owner's house |  84 (2.3) |
| Bathing/ Grooming the animal |  68 (1.8) |
| Taking something from the animal |  61 (1.6) |
| Trying to feed the animal |  54 (1.5) |
| Touching a wound or painful spot on the animal |  51 (1.4) |
| Walking into the owner's yard  |  36 (1.0) |
| Delivering the mail |  35 (0.9) |
| Trying to put the animal in a crate |  30 (0.8) |
| Giving medication to or cleaning a wound on the animal |  27 (0.7) |
| Waking up in a room with a bat |  26 (0.7) |
| Greeting a new animal |  22 (0.6) |
| Checking the animal for a collar and tags |  11 (0.3) |
| Bitten by a wild animal |  10 (0.3) |
| Repairing/ Installing an item on the owner's property |  9 (0.2) |
| Bitten by a bat |  7 (0.2) |
| Yelling at or hitting the animal |  7 (0.2) |
| Worker from phone / cable company that is on or near the owner's property |  2 (0.1) |
| Other | 1296 (34.8) |
| Missing |  382 (10.3) |

Of persons involved in an animal exposure, 77.0% were given an antibiotic, 38.6% received a tetanus shot, and 5.2% underwent rabies post-exposure prophylaxis (Table 5). Antibiotic rates were similar for both cat and dog bites. Bites by other animals resulted in much lower rates of antibiotic prescription, at 32.2%, likely due to a large number of these other animals being bats, which do not give large visible bite wounds. However, it is clear that post-exposure prophylaxis is used much more often in bites by other animals, with 39.3% of individuals bitten by other animals receiving post-exposure prophylaxis. Those victims who received none of the below listed medical treatments for their bite constituted 16.6% of all bites.

Table : Treatments received by victims, 2015-2016

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Treatment type | All bites (N=3722)n (%) | Dog bites (N=2701)n (%) | Cat bites (N=838)n (%) | Other bites (N=183)n (%) |
| Antibiotic | 2867 (77.0) | 2141 (79.3) |  667 (79.6) | 59 (32.2) |
| Post-exposure prophylaxis (rabies vaccine) |  192 (5.2) |  75 (2.8) |  45 (5.4) | 72 (39.3) |
| Tetanus shot | 1435 (38.6) | 1053 (39.0) |  320 (38.2) | 62 (33.9) |

Of those who received post-exposure prophylaxis, the majority (76%) received it because they were bitten by a domestic animal that could not be watched for survival or by an animal unavailable for rabies testing (Table 6). Of those who received post-exposure prophylaxis 9.9% were directly exposed to a rabies positive animal. The remaining 14.1% received PEP when they did not need to; their doctor either suggested it when an animal could be observed to see if it developed rabies symptoms or they requested it despite an animal being observable. Many of these individuals did not complete the entire PEP course; they halted after being informed it was unnecessary by ACHD. Note that as seen in Table 2, 20 persons were exposed to rabies positive animals, yet Table 6 shows that only 19 persons exposed to rabies positive animals received post-exposure prophylaxis; this difference is due to one person who was exposed to a rabies positive animal refusing treatment with post-exposure prophylaxis. As of the writing of this report, this individual has not developed rabies.

Table : Reasons for receiving post-exposure prophylaxis, 2015-2016

|  |  |
| --- | --- |
| Reason (N=192) | n (%) |
| Exposed to rabies positive animal |  19 (9.9) |
| Exposed to animal that could not be observed or tested | 146 (76.0) |
|  Invalid Reason (received PEP unnecessarily) |  27 (14.1) |

There were 838 total exposures due to cats. Analysis of cat exposures indicates that only 63.6% of cat exposures involved cats with documented vaccination (Table 7). There were 679 exposures to pet cats; the vaccination rate 74.4% in exposures involving pet cats. Stray/feral cats were responsible for 159 total human exposures, and only 17.6% of feral/stray cats were vaccinated. This figure for stray cats may seem relatively high, but some individuals reported that the stray cat was seen regularly in the area and that either they or someone they knew brought the stray cat to be vaccinated. A total of 2701 exposures were due to dogs, and 72.8% of these exposures involved an animal that was known to be vaccinated. Dogs also had lower rates of confirmed unvaccinated animals at 3.3% compared to 10.9% for pet cats (results not shown).

Quarantine rates were similar in both cats and dogs at 68.5% and 70.5%, respectively (Table 7). Many of those marked no or unknown for quarantine status were likely due to either the victim refusing to identify the owner (and thus, no quarantine notice can be given) or due to not knowing the owner of the cat/dog, if it was a pet. Also, note that although typically only pets can be quarantined, for stray cats that are regularly seen by the victim, a pseudo-quarantine can be imposed where the victim can observe the cat’s survival 10 days after the bite; this is why there were stray/feral cats listed as “quarantined”.

Table : Follow-up information in reported cat and dog bites, 2015-2016

|  |  |  |
| --- | --- | --- |
|  | Dogs (N=2701)n (%) | Cats |
| **All Cats (n=838)****n (%)** | **Pet** **(n=679)****n (%)** | **Stray/Feral (n=159)****n (%)** |
| Quarantined | 1905 (70.5) | 553 (66.0) | 505 (74.4) | 48 (30.2) |
| Prior Rabies Vaccination | 1967 (72.8) | 533 (63.6) | 505 (74.4) | 28 (17.6) |

Note: all percentages in the above table are column percentages for the specific animal category.

Mixed breed dogs were the most common, at 19.1% of reported bites (Table 8). Three dog breeds were overrepresented in bite data relative to county breed registry statistics obtained from the Allegheny County Treasurer’s Office. These three are: Pit bulls (2.5% of registered dogs and 14.4% of bites) German Shepherds (2.9% of registered dogs and 5.8% of bites) and Rottweilers (0.8% of registered dogs and 2.0% of bites). All breeds that were responsible for at least 15 bites are displayed in Table 8; many other breeds constitute the remaining 412 bites, all with less than 15 reported bites. Breed information was unavailable for 22.5% of dog bite reports.

 Table : Breeds of dogs in reported bites, 2015-2016 (N=2701)

|  |  |
| --- | --- |
| Breed Name |  n (%) |
| Mixed Breed | 516 (19.1) |
| Pit Bull | 388 (14.4) |
| German Shepherd | 157 (5.8) |
| Labrador Retriever |  66 (2.4) |
| Bulldog |  62 (2.3) |
| Boxer |  54 (2.0) |
| Rottweiler |  53 (2.0) |
| Husky |  43 (1.6) |
| Beagle |  40 (1.5) |
| Golden Retriever |  35 (1.3) |
| Jack Russell |  35 (1.3) |
| Chihuahua |  34 (1.3) |
| Mastiff |  27 (1.0) |
| Dachshund |  26 (1.0) |
| Australian Shepherd |  24 (0.9) |
| Shih-Tzu |  24 (0.9) |
| Great Dane |  23 (0.9) |
| Labradoodle |  22 (0.8) |
| Poodle |  19 (0.7) |
| Yorkshire Terrier |  19 (0.7) |
| Cocker Spaniel |  15 (0.6) |
| Breeds with <15 bites | 412 (15.3) |
| Missing/unknown | 607 (22.5) |

MedExpress clinics were the treatment facilities most often visited by animal bite victims; 22.1% of all bites were treated at MedExpress clinics (Table 9). UPMC urgent care facilities also were relatively common, with 3.0% of all victims. Other clinics and urgent care facilities (such as university clinics) treated 0.6% of victims.

No treatment facility was listed for 18.1% of bites; it is likely many of these should be classified as “did not seek care” (which was an option listed by 1.1% of victims). As previously mentioned, 618 individuals were reported as receiving none of antibiotics, tetanus shot, or PEP; of these, 285 were listed as missing for medical facility; this suggests that potentially 285/675 or 42.2% of those listed as “missing” for hospital may better be classified as “did not seek care” (results not shown). Hospitals made up the majority of the rest of treatment locations, with UPMC Children’s, Allegheny General, Jefferson, and St. Clair the four most commonly visited hospitals at 6.3%, 5.2%, 4.4%, and 4.4%, respectively. Facilities with less than 10 victims are not listed in Table 9; these facilities treated a total of 95 victims.

Table : Medical facilities where victims were treated for reported animal bites, 2015-2016

|  |  |
| --- | --- |
| Facility Name | n (%) |
| MedExpress clinic (any) | 821 (22.1) |
| UPMC Children’s Hospital | 235 (6.3) |
| Allegheny General Hospital | 195 (5.2) |
| Jefferson Hospital | 165 (4.4) |
| St. Clair Hospital | 163 (4.4) |
| UPMC Shadyside Hospital | 118 (3.2) |
| UPMC Mercy Hospital | 114 (3.1) |
| UPMC McKeesport Hospital | 111 (3.0) |
| UPMC Passavant Hospital | 111 (3.0) |
| UPMC Urgent Care facility (any) | 111 (3.0) |
| UPMC (unlisted branch) | 107 (2.9) |
| UPMC East Hospital | 106 (2.9) |
| Heritage Valley (any hospital branch) |  73 (2.0) |
| Medi-Help clinic (any) |  73 (2.0) |
| Ohio Valley General Hospital |  71 (1.9) |
| UPMC Presbyterian Hospital |  68 (1.8) |
| UPMC St. Margaret Hospital |  66 (1.8) |
| Forbes Regional Hospital |  56 (1.5) |
| Allegheny Valley Hospital |  46 (1.2) |
| Did not seek care |  42 (1.1) |
| Other urgent care facility |  22 (0.6) |
| Other clinic |  21 (0.6) |
| West Penn Hospital |  17 (0.5) |
| Facilities with <10 victims treated |  95 (2.6) |
| Missing/Unknown | 675 (18.1) |

As can be seen in Figure 4, by victim’s residence, most of Pittsburgh, including downtown Pittsburgh, had a relatively low rate of animal bites. However, neighborhoods that fall on the northern side of the Allegheny River exhibited very high bite rates relative to both the rest of Pittsburgh and Allegheny County as a whole. This was mainly centered in the 15202 (Ben Avon, Avalon, Bellevue) 15212 (Troy Hill, North Shore, Allegheny Center), and 15214 (Perry North, Perry South, Northview Heights) ZIP codes (results not shown). The species responsible for bites in this area generally followed similar patterns to the county as a whole, with 74.3% due to dogs, 21.4% due to cats, and 1.9% due to bats (results not shown). Two exposures to rabies also happened in this area, both in the 15212 ZIP (results not shown).

Overall, the municipalities within Allegheny County that had the highest rate of animal bite occurrence were generally in the northeastern and southeastern corners of the county. In the northeast, Fawn, Tarrentum, Harrison, and Frazier all had rates of bites that exceeded 300 per 100,000 population (Figure 4). In southeastern Allegheny County, the rate was higher at >400 bites per 100,000 population. Jefferson Hills, Clairton, West Mifflin, McKeesport, and Dravosburg were the municipalities with the highest rates of animal bites in southeastern Allegheny County (Figure 4).

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Figure : Animal bites per 100,000 population, by victim's zip code of residence

# Discussion

Overall, there were 3722 unique bites reported to the Allegheny County Health Department in 2015 and 2016. In 2016, 1912 exposures were reported, a 5.6% increase from 1810 reports in 2015. Of the reported bites, 20 (0.5%) involved an animal that tested positive for rabies.

Of the 3722 total reported bites, 2701 (72.6%) involved dogs, and none of the dogs were confirmed to be infected with rabies. The top 5 breeds involved in exposures were the Pit Bull, German Shepherd, Labrador Retriever, Bulldog, and Boxer. These were the seventh, third, first, fifteenth, and tenth (respectively) most common breeds in Allegheny County, according to 2016 license counts on record with the Allegheny County Treasurer’s Office. Note that all dogs kept as pets in Allegheny County are required to be licensed and that rabies immunization is legally required under state law, but proof of vaccination is not required for licensure. Unvaccinated dogs constituted 3.3% of reported exposures.

Cats were responsible for 838 (22.5%) reported bites. Five cats (0.6% of all cat exposures) tested positive for rabies and all five that were either strays or feral. Unvaccinated cats constituted 12.7% of reported exposures. The percentage of unvaccinated pet cats was slightly lower at 10.9%. It is unclear if the reason for the low vaccination rate is unique to house cats, which have low risk for exposure to rabies positive animals.

There were 179 animal exposures to animals that were tested for rabies. Twenty of these 179 exposures involved an animal that tested positive for rabies. Exposures to rabies positive animals included ten exposures to bats, five to cats, three to raccoons, one to a skunk, and one to a coyote. Since none of the animals that tested positive for rabies were pets, domestic animals remained free of rabies between 2015 and 2016. Wild animals are the main vector for human rabies exposure, and avoiding close contact with wild animals, especially bats, raccoons, and skunks that pose the greatest risk, remains the best way to prevent human rabies exposure.

Post-exposure prophylaxis (PEP) was given to victims in 192 cases (5.2% of all bites). Of the victims that received PEP, 27 (14.1%) received it in unnecessarily: there was no immediate need for the vaccine due to the animal being available for observation (and the animal was confirmed as alive after the 10 day quarantine). Unnecessary usage of PEP is an area of concern for ACHD due the vaccine’s expense and requirement for multiple doses, which could put undue burden on people who have no need to be vaccinated. Individual bite reports suggest that unnecessary usage of PEP had two primary causes: doctors recommending it in cases where ACHD does not recommend it, and victims choosing to get vaccinated against ACHD recommendations.

Antibiotics are prescribed at a physician’s discretion based on severity of wound, and tetanus shots are primarily indicated if the bite/scratch resulted in a puncture wound and the victim has not received a tetanus shot in the last 10 years or does not know the date of their last tetanus shot.16 Both of these methods of treatment were used in a relatively large number of reported bites, with antibiotics prescribed for 77.0% of bites, and tetanus shots given for 38.6% of all bites. Without detailed information on severity of bites due to problems with data collection, it is unclear if antibiotic prescription or tetanus shots at these levels were necessary due to a large number of severe injuries.

Examining the geographic distribution of animal bites within the county suggests some clear trends of where bites are occurring. The higher rates of bite present in both the northeastern and southeastern corners of the county provide information that could help further target animal safety efforts in order to reduce both risk of rabies exposure and to potentially reduce animal bite related sources of morbidity. Examining these trends in the future could help see if the pattern observed across 2015-2016 about where bites are occurring is truly a reflection of higher risk for bites in those areas. Having better address-level data for both victim’s residence and location of bite may help to better pinpoint if bites tend to cluster in certain areas within these high risk ZIP codes and municipalities.

There were no cases of human rabies in Allegheny County, similar to past years, despite twenty known human exposures that could have resulted in rabies without adequate identification through the animal bite reporting system. There were no confirmed cases of dog rabies in Allegheny County, consistent with past years, good evidence that rabies vaccinations in pet dogs are effective at preventing rabies in dogs.

## Future REcommendations

1. Focus rabies prevention messages to the public on avoiding direct contact with wild animals. Wild animals (including stray cats, raccoons, skunks, bats, and coyotes) were solely responsible for all human exposures to rabies positive animals in Allegheny County in 2015-2016.
2. Eliminate miscommunications and misunderstandings of PEP protocol by Allegheny County physicians and the public. It is unlikely that ACHD could completely prevent individuals from choosing to get PEP when it is unnecessary, as some individuals may feel safer with the vaccine if they were bitten by a wild animal, even if the wild animal was confirmed to be rabies negative. Ensure providers know that PEP is not immediately necessary if the animal is available for observation or testing.
3. Increase vaccine coverage in pets, especially in cats. The vaccination status of a large number of cats and dogs could not be established, which means that the true percentage of cats and dogs that are unvaccinated is underestimated by this report. It may also be beneficial for future data collection to document whether an animal was up-to-date on rabies vaccines rather than just whether it was ever vaccinated, as animals without up-to-date rabies vaccination are at higher risk of contracting rabies than those with up-to-date vaccinations.
4. Reported bites currently have high rates of antibiotic prescription (~80%) and tetanus shots (~40%). However, data collection of wound data prevented detailed analysis of whether or not these were above expectations based on wound types. In future analysis with complete data on type of wound, tetanus and antibiotic prescription rates should be monitored to ensure they are not being overused.
5. Monitor the number of bites reported in 2017-2018. As ACHD transitions to electronic reporting instead of paper forms transmitted by fax later in 2017, it will be essential to monitor the number of bites reported, as a reduction could be a sign of underreporting, or an increase a sign that past methods were not accurately measuring the number of animal bites in Allegheny County.

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