

# Outbreak of Rabies among Humans, Dogs and Livestock, Awutu-Senya East Municipality, Ghana, 2019

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**KEYWORDS:** Human rabies, Post-exposure prophylaxis, Dog vaccination, Rabies virus, Dog bite, Neglected zoonotic disease

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## ABSTRACT

**Introduction:** Rabies is a neglected zoonotic disease caused by the Rabies virus (RABV). Ninety-percent of human rabies are dog-mediated. Globally there are 59,000 human rabies annually. On June 16 2019, a 4-year-old girl from the Awutu-Senya East Municipality of Ghana, died following symptoms of aggression, hyper-salivation and hydrophobia. She had a dog scratch five weeks prior. We confirmed the outbreak, determined its magnitude, identified associated factors and implemented control measures. **Methods:** We interviewed community members to understand potential exposures to RABV. We reviewed the animal bite records, clinical notes of human rabies cases and initial line-list. We conducted community-based rabies surveillance for animal bites and confirmed RABV by Polymerase Chain Reaction of brain tissue of dead human and animals. We updated the line-list with demographic, exposure, and outcome variables of bite victims. Quantitative data was analyzed descriptively, and findings presented as frequencies and proportions. **Results:** Overall, 155 dog bites were identified, among which six human rabies deaths were recorded (Attack rate=3.9%). Males were 51.6% (80/155) of bite victims, while children 5-14 years constituted 27% (40/147). About 86.5% (134/155) of bites were by unvaccinated dogs, and stray dogs bit 80.6% (125/155) of individuals. Category III bites were 35% (50/141). RABV was isolated from 16.7% (1/6) of human deaths and 30% (3/10) of rabid dog. We suspected rabies infection in a goat. Dogs roamed unattended within communities. **Conclusion:** This rabies outbreak was dog-mediated. Poor pet ownership and limited vaccination of dogs were associated factors. Mass dog vaccination, prompt post-exposure prophylaxis and risk communication were critical interventions implemented.

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## Introduction

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Rabies is a neglected zoonotic disease [1]. Among the 15 viruses of the *genus Lyssavirus* that cause Rabies, the Rabies Virus (RABV) is the leading cause worldwide [2]. Rabies affects poor populations, mostly in low and middle income countries [3,4]. Global human rabies deaths are estimated at 59,000 annually with a loss of 3.7 million disability adjusted life years. Rabies deaths are underestimated due to poor surveillance, weak data capture, misdiagnosis, and poor coordination between human and animal health sectors [1]. Africa contributes annually to 21,476 (36.4%) of human rabies deaths globally [5].

The RABV is transmitted through the bite of a rabid mammal when there is salivary shedding of the virus [6]. In humans, the average incubation period is 1-3 months, but can range from days to years [3,7]. Death usually occurs, with symptom onset although few recoveries have been recorded [1,7,8,9]. Rabies-associated costs include: premature deaths, post-exposure prophylaxis (PEP) costs and health system costs [1]. Vaccination of pets and prompt PEP to dog bite victims are critical to break the cycle of transmission [2,10]. PEP is an expensive intervention, and Africa is estimated to have the least annual budgets for PEP leading to the high prevalence of the disease in the continent [10]. In Ghana, poor surveillance, inadequate investigations and management of dog bites is a challenge to rabies control [11,12]. In Ghana, about 25 human rabies deaths were recorded between January 2009 and July 2011. A total of 144 human rabies deaths occurred between 1986 to 2003 nationwide [12]. The Awutu-Senya East Municipality in the Central Region of Ghana has recorded two uninvestigated suspected human rabies deaths from 2017 to 2018 in the municipality, but there is anecdotal evidence that more human rabies deaths occur unrecorded.

On June 16 2019, a 4-year-old female presented to the municipal hospital in Awutu-Senya East in Ghana. She had symptoms of aggression, hyperventilation, hyper-salivation and hydrophobia. She was referred as a suspected human rabies case to the Korle-Bu Teaching Hospital, a tertiary hospital in the capital of Accra, where she died after eight hours. The hospital notified the municipal disease

surveillance department. A team was constituted to confirm the outbreak, to determine its source and magnitude, to identify exposed individuals, and to implement control measures.

## Methods

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### Investigation site

The outbreak occurred at the Awutu-Senya East Municipality (ASEM) in the Central Region of Ghana, with an estimated population of 131,648 [13]. There are five sub-districts with 26 private health facilities, one government hospital, one health center and 24 community-based health planning and services zones. The municipality has a veterinary clinic that provides services to the animal population. ASEM was an estimated 4830 dogs, 6740 goats, 3154 Cattle and 4911 sheep. Only 4% of the dog population were vaccinated in February 2019. The Municipal Veterinary Services estimates up to 70% of the dogs are stray in the streets without care of a person or without a leash. The municipality has an existing Public Health Emergency Management Committee which is coordinated by the municipal political authority to help with outbreak preparedness and response. This committee has the participation of both animal and human health authorities in the response to zoonotic diseases with the One Health Approach.

### Data collection

Using an interview guide, we interviewed the head of disease surveillance at the municipal health authority to obtain information on the local response and reviewed their initial line list. We interviewed community leaders, families of victims and owners of rabid animals to understand the extent of potential community exposure to RABV. We interviewed local outbreak response team that involved both animal and human health authorities to understand the One Health collaboration within the municipality.

We reviewed and extracted animal bite surveillance data for April 1 to December 31 2019, from the District Health Information Management Software (DHIMS II). We also reviewed clinical notes of human rabies deaths at the private clinic and the

municipal hospital over the same period. We abstracted data on age, sex, signs, symptoms, date of bites, administration of PEP and outcome of animal bite victims. We reviewed the animal health data for reported rabid animals to the municipal veterinary health authority. Based on reviewed clinical data, we formulated outbreak case definitions and also described the categories of contact reported bite victims had with implicated dogs.

Contacts were described in three categories [14]

Category I: Touching or feeding animals, licked on intact skin with secretions or excretions of rabid animal or person

Category II: Sustained abrasions or scratches without bleeding

Category III: Transdermal bites or scratches, licks on broken skin, contamination of mucous membrane with saliva

### **Case Definition**

A suspected case of human rabies death was any person residing in ASEM, that had presented to a health facility with hyper-salivation, hyperventilation, hydrophobia, aggression, and fever, with a history of dog bite from April 1 to December 31 2019. A probable human rabies case was any suspected human rabies death with an epidemiological link to a confirmed rabid dog. A confirmed human rabies death was any dead human with laboratory isolation of RABV.

Using the case definition and the description of contacts, we developed a checklist to conduct a community-based animal rabies surveillance. This involved active search for dog bite victims and symptomatic rabid animals within the communities [15]. We engaged in risk communication to encourage community members to also report bites. We updated the line lists.

### **Laboratory assessment**

We performed postmortem on human rabies and animal rabies cases through a one health collaboration. Brain biopsy samples taken were the hippocampus, medulla oblongata and the

cerebellum. Postmortem for human rabies death was conducted at the Korle-Bu Teaching Hospital pathology department and brain samples taken through partnership by pathologists and veterinarians. Permission was sort from owners of suspected rabid animals after explaining to them the need and process of euthanasia. Animals were euthanatized and decapitated by veterinary offices at the municipal veterinary clinic according to standard recommendation [16]. The head was taken for testing. Remains of carcass was triple wrapped and incinerated. Both human and animal samples obtained were packaged and transported at 4°C within 6 hours to the national veterinary laboratory where chromatographic immuno-assay, direct fluorescence assay and polymerase chain reaction tests were performed.

### **Management of Dog Bite Cases**

We developed a bite management record system at the hospital. We assessed the risks of bite victims, and determined their need for rabies vaccine administration using standard recommendations [14].

### **Environmental and health facilities assessment**

Using a checklist developed by the outbreak investigation team, we assessed the private health facility and the municipal hospital for availability of appropriately stored rabies vaccines and immunoglobulins, as well as registers for management of animal bite victims. We also assessed the municipal veterinary clinic to observe quarantine sites for symptomatic animal rabies.

### **Data analysis**

We entered quantitative data into Microsoft Excel version 16, coded data and performed descriptive analysis using Stata version 15.0. Results were presented as frequencies and proportions in tables and charts. We drew epidemic curves to describe the outbreak in humans and animals.

### **Ethical considerations**

We obtained permission from the Ghana Health Service Disease Surveillance Department and the Municipal Health Directorate. We obtained verbal consent from interviewees after explaining to them the purpose of interviews. Data collected were de-identified to ensure confidentiality.

## Results

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### Descriptive epidemiology

Overall, 155 dog bite victims were recorded from April to December 2019 (Figure 1). Active bite surveillance identified 84.5% (131/155) of all the bite victims and only 15.5% (24/155) identified by the routine surveillance [Table 1](#). Bite recorded rose sharply to a maximum in July and steadily declined along until only a case was recorded in December [Figure 1](#). Children 5-14 years old constituted 27.2% (40/147) of bite victims, and 51.6% (80/155) were males. Among bite victims, 86.5% (134/155) were exposed to unvaccinated dogs [Table 2](#), and Up to 71.2% (109/153) of bite victims had contact with confirmed rabid dogs [Table 1](#). Most of the bites constituting 91.8% (134/146) were unprovoked. About 80.6% (125/155) of bite victims had contact with stray unattended dogs, and 15.5% (24/155) were bitten by dogs that were their pets [Table 2](#).

Six human rabies deaths occurred (Attack rate=3.9%) within three communities in ASEM, with case fatality rate of 100% (6/6). Human deaths occurred in these communities as follows; Ghana Flag 17% (1/6), Ofaakor 50% (3/6), Number-nine 33% (2/6). The highest number of human rabies death were recorded in July [Figure 2](#). Females constituted 50% (3/6) of the human rabies deaths. Median age of human rabies was 24 years (Interquartile range=4-52). Among the human deaths, only 17% (1/6) was tested and confirmed by PCR following autopsy, while 50% (3/6) were epidemiologically linked to bites by rabies positive dogs. Others, constituting 33.3% (2/6) were suspected human rabies deaths that were bitten by unconfirmed rabid dogs that were killed and buried by community members. The commonest symptoms manifested by human cases were hydrophobia, hyper-salivation, aggression, hyperventilation, and fever [Table 3](#).

Overall, four rabid animals were tested including three dogs and one goat. We identified ten rabid dogs in ASEM. About 30% (3/10) of suspected rabid dogs were laboratory confirmed, and 30% (3/10) were epidemiologically linked to human rabies deaths.

The remaining 40% (4/10) were suspected clinically diagnosed dog rabies. One clinically suspected goat rabies was recorded in June which was the peak month of occurrence of animal rabies death [Figure 3](#).

### Index Human Rabies Case

The index human case, a 4-year-old girl, living at 'Ghana Flag' community, was scratched on the left side of her face on May 6, 2019 by a neighbor's dog. The attack was unprovoked and dog was killed by community members and carcass buried on the same day. She reported to a local private clinic, was discharged same day on oral antibiotics, but no PEP was administered for rabies prevention because it was not available in the clinic and guardian of the child could not afford the vaccine and immunoglobulin from an external pharmacy. The child was asymptomatic until June 14, 2019 when she developed fever, headache, and general weakness. The parents treated her at home for malaria until June 16, 2019 when she started exhibiting hyperventilation, hyper-salivation, hydrophobia and aggression. She presented to the municipal hospital and was referred to Korle-Bu Teaching Hospital (KBTH) in the capital city of Accra, on June 16 2019. At KBTH, she was managed on oxygen in a quiet environment with fluid support. Full blood count results were normal and no other laboratory tests were done. She died after seven hours

### Suspected Livestock Case

In June 2019, a rabid dog bit a pregnant goat in ASEM. The bite wound was washed with an antiseptic and veterinary officers quarantined the goat for observation daily for 10 days. On day seven, the goat became aggressive and broke its right horn, it chewed on inedible items and was drooling. Goat was euthanized for testing because it became weak with labored breathing on the seventh week.

### Laboratory results

Gross pathology of the index human case indicated Rabies encephalitis and tested positive for RABV on chromatographic immuno-Assay test, fluorescence Assay and polymerase chain reaction tests. Fifty-percent (3/6) of dog samples tested positive for RABV and the goat sample tested negative.

### **Environmental and health facility assessment**

The private clinic first attended by the index human case had no rabies vaccines, but the municipal hospital had only 25 doses of vaccines for PEP. No rabies immunoglobulin was available in the entire municipality. The veterinary department had no quarantine area for suspected dogs. Quarantine procedures were done in households. We disinfected homes of rabid human and animals with 5% Chlorine [17].

### **Management of Dog Bite Cases**

Bite wounds were washed for 15 minutes with antiseptic soap. Oral amoxicillin and metronidazole were administered for bite wounds. Category II and III exposures were administered with a five-dose regimen of rabies vaccine. Each dose was administered intramuscularly into the deltoid muscle, and for young children, the antero-lateral aspect of the thigh. Initiation of the PEP was done immediately when bite was reported. PEP was not delayed because of anticipated outcome of observed implicated dogs or by wait for laboratory results. We discontinued vaccine for bite victims after dogs tested negative of RABV. The successful risk assessment and management of bite victims was possible due to the effective data sharing between the municipal veterinary and human health authorities in a comprehensive one health system.

### **Discussion**

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Human and dog rabies is reported in Ghana, and human rabies is usually clinically diagnosed without laboratory confirmation. We confirmed one human rabies case and demonstrated a likely rabies infection of livestock which was dog-mediated at ASEM. In Indonesia and Bhutan, canine and livestock rabies outbreaks have been documented [18,19]. The isolation of RABV from a human is very significant to inform the level of one health collaboration in response to the outbreak. This outbreak was dog-mediated, with dogs being responsible for all reported animal bites as demonstrated in other studies [3,19].

Males were slightly more exposed as bite victims RABV. Children 5-14 years were the most affected age group. This age group play with roaming dogs in the communities and hence were most exposed, a finding that has been documented [3,20]. In southern Nigeria, analysis of animal bite data showed that older persons reported dog bites more from passive surveillance of bite cases [21]. The community-based animal rabies surveillance we implemented for active search of bite victims has been demonstrated to better involve stakeholders in rabies outbreak management [15]. We identified majority of bite victims for interventions through this surveillance strategy, and because barely one-fifth of bite victims was identified by passive surveillance. This shows the limitation of routine animal bite surveillance. Haiti introduced the community-based animal rabies surveillance, and several rabies exposures were identified, preventing human rabies deaths, and 18 times increase in animal rabies was recorded [15]. It is important to note that over 80% of individuals were attacked by stray dogs in the communities unprovoked. This demonstrates poor pet ownership in ASEM posing great risks to animal bites. A similar finding from a rabies investigation in Bhutan was made [18]. In a study in Maputo, however, it was observed that pet dogs were more implicated among bite victims [3].

Most bite victims had various degrees of contact with unvaccinated dogs, although that is a cheaper intervention for rabies control [3,12]. This is an indication of the poor dog vaccination practices ASEM. Most of these dogs that attacked victims unprovoked were killed by community members and carcass buried. This also is an important risk to potentially spreading the RABV as described in a study in Nigeria [21]. This practice also did not allow assessment and testing of all suspected rabid dogs by the veterinary services. In two instances, the outbreak team exhumed buried dog carcasses and these tested positive.

Poor bite management was a missed opportunity in this outbreak leading to mortalities. Poor bite management contributes to human rabies deaths in Ghana [9]. The inadequate stock of rabies vaccines in facilities and high cost of rabies immunoglobulin to bite victims in ASEM contributes to poor bite

management. In the Greater Accra Region of Ghana, 76% of health facilities did not have rabies vaccines and in the Eastern Region, about 82% of bite victims do not receive PEP because of non-availability and high cost of purchase [9,13]. With the support of the World Health Organization and Food and Agricultural Organization, we conducted free mass dog vaccination as a key intervention. Risk communication was intensified to encourage appropriate pet ownership, participation in dog vaccination campaign and to encourage early reporting of dog bites to the clinic.

We recommended that the municipal political authorities provide quarantine facilities for the municipal veterinary services to discourage home observations of implicated animals. The One-Health approach, the involvement of government agencies and community members was an advantage to our investigation. The findings must inform new approaches to rabies control in the ASEM and in other communities in Ghana.

### **Limitations**

The killing and burial of diseased dogs by community members did not allow for laboratory confirmation of some suspected rabid dogs. That notwithstanding, the community-based bite surveillance helped track all contacts to these dogs for prompt post-exposure prophylaxis.

### **Conclusion**

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The rabies outbreak in Awutu-Senya East Municipal in 2019 was dog-mediated and affected humans, dogs, and livestock. Rabies virus was the infective agent isolated by standard laboratory tests from human and dogs. Active search of dog bite victims, timely post-exposure prophylaxis, risk communication and mass dog vaccination were key interventions. These were successful due to the community engagement and multi-sectoral participation in the spirit of One Health.

### **What is known about this topic**

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- Rabies is a neglected zoonotic disease;
- Rabies affects poor populations, mostly in low and middle income countries.

### **What this study adds**

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- The mixed rabies outbreak in Awutu-Senya East Municipal in 2019 was dog-mediated. Rabies virus was the infective agent isolated by standard laboratory tests;
- Active search of dog bite victims, timely post-exposure prophylaxis, risk communication and mass dog vaccination were key interventions.

### **Competing interests**

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The authors declare no competing interests.

### **Authors' contributions**

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PHDA, ABA, FA, EEA, DKA, and EK designed the study methodology and data collection tools. PHDA, ABA, FA, KS, AAO, and EEA collected, cleaned, and analyzed data. PHDA and ABA prepared tables and figures. PHDA, ABA, FA, DKA, and EEA developed manuscripts for intellectual content. PHDA, ABA, KS, AAO, BW, DKA, DAB, and EK reviewed the manuscript. All authors approved the final manuscript before submission.

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## Tables and figures

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**Figure 1:** Trend of dog bites in Awutu-Senya East, 2019

**Figure 2:** Epicurve showing number of human rabies deaths by months

**Figure 3:** Epicurve showing the number of animal rabies death

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**Table 1:** Socio-demographic and exposure factors of contacts in rabies outbreak, Awutu-Senya East Municipal, 2019

<b>Factors (N)</b>	<b>Frequency (n)</b>	<b>Proportion (%)</b>
<b>Age (N=147)</b>		
<5	31	21.1
5-14	40	27.2
15-24	23	15.7
25-34	17	11.6
35-44	20	13.6
>=45	16	10.9
<b>Sex (N=155)</b>		
Male	80	51.6
Female	75	48.4
<b>Source of exposure (N=153)</b>		
Rabid dog	109	71.2
Unknown dog	33	21.6
Rabid human	11	7.2
<b>Exposure category (N=141)</b>		
Category I	76	53.9
Category II	15	10.6
Category III	50	35.5
<b>Under which surveillance was contact identified? (N=155)</b>		
Enhanced	131	85.1
Routine	24	15.5

*Note: Varying N is due to incomplete or missing data*

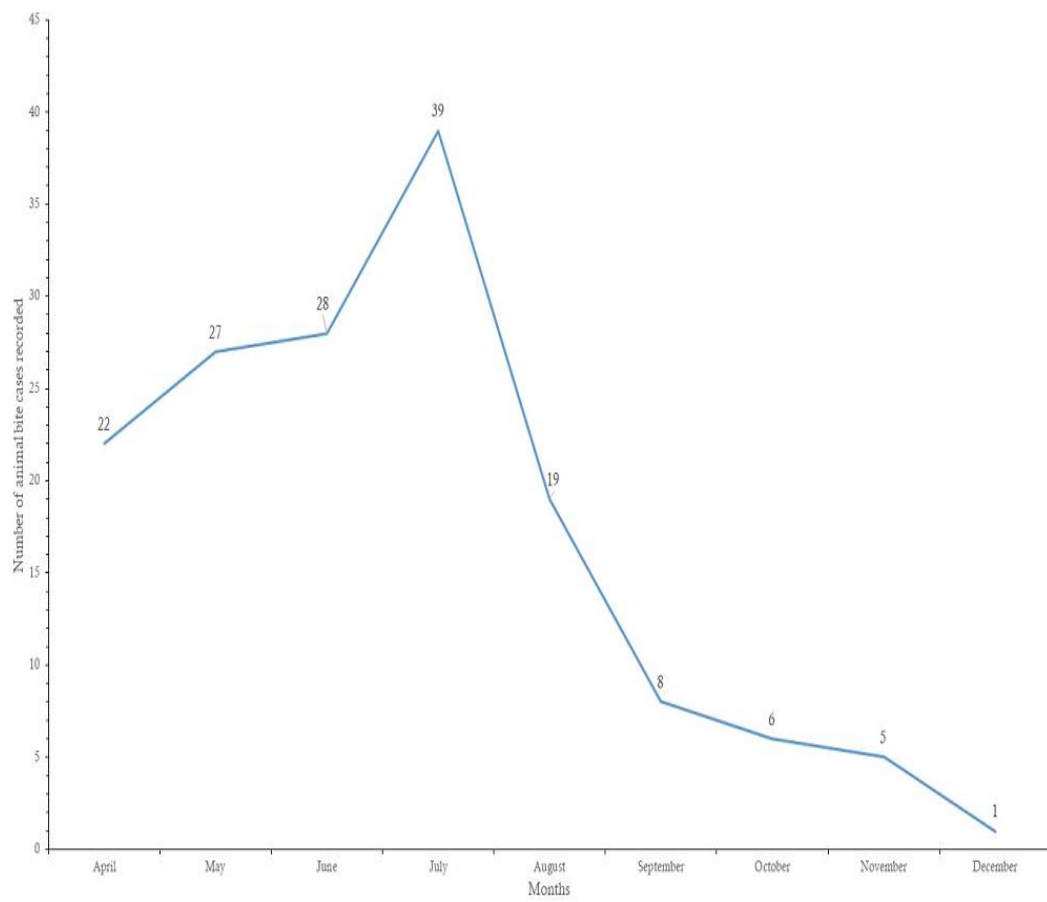
**Table 2:** Characteristics of dogs implicated in recorded bites during rabies outbreak, Awutu-Senya East Municipal, 2019

Factors (N)	Frequency (n)	Percentage (%)
<b>Nature of Dog bite (N=146)</b>		
Unprovoked	134	91.8
Provoked	12	8.22
<b>Relationship of bite victim with dog (N=155)</b>		
Stray dog	125	80.6
Pet dog	24	15.5
Neighbor's dog	6	3.9
<b>Was dog vaccinated? (N=146)</b>		
Unvaccinated	134	91.8
Unknown	12	8.2
Vaccinated	0	0.0
<b>What was the outcome of dog? (N=153)</b>		
Killed by community members	104	68.0
Alive	25	16.3
Died from illness	13	8.5
Unknown	7	4.6
Euthanized by veterinarian	4	2.6

*Note: Varying N is due to incomplete or missing data*

**Table 3:** Frequency of symptoms among human rabies cases in Awutu-Senya East Municipal, Ghana (N=6)

Symptom	Frequency (n)	
	Yes	No
Hydrophobia	6	0
Hyper salivation	6	0
Aggression	5	1
Hyperventilation	4	2
Fever	4	2
Headache	2	4
Tingling sensation	2	4
Seizure	1	5
Paralysis	1	5



**Figure 1:** Trend of dog bites in Awutu-Senya East, 2019