A descriptive and categorical analysis of age, gender and seasonal pattern of dog bite cases and rabies-like-illness among humans in Liberia, 2008-2012

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Summary

Dog bite cases among humans were investigated in light of treatment-seeking preferences of rural and urban Liberian public and were used to estimate yearly incidence of rabies-like-illnesses in the country during the post-conflict period, 2008-2012. Dog bite records were retrieved countrywide and re-validated at county hospitals. Data at the Liberian Government Hospital (LGH), Buchanan; Phebe Hospital and Nursing School (PHNS), Suakoko; and Tellewoyan Memorial Hospital (TMH), Voinjama were reviewed and categorized into site of bite, victim’s age, gender, dry or wet seasonal occurrence. Annual incidence of rabies-like-illness was estimated from a probability tree model of dog bite cases from suspect rabid dogs in the country. Four hundred and ninety-one dog bite cases were reported country-wide during the study period. Some 488 (99%) cases were validated at county hospitals and were enlisted into the study. Highest number of cases (n=150, 30.7%) involved children below 10 years of age, followed by the age group of 11-20 years old (108, 22.13%), and 21-30 years old (51, 10.45%). Lowest number of cases (31, 6.35%) was among individuals that were above 51 years old. There was a significant difference between the genders (p < 0.05) only among children 1-10 years old, where more male (91, 60.7%) than female (59, 39.3%) were involved. We estimated 404 cases of rabies-like-illness with resultant death in 2008-2012, and an annual average of 81 human deaths. These findings indicate a need to prioritize the surveillance and control of rabies in Liberia.

Introduction

Dog bite injury among humans is a well known public health problem worldwide. In the developed and developing countries alike, the risk of rabies virus...
transmission is a most feared complication in dog bite injuries (Monson, 1985; Lewis and Stiles, 1995; Presutti, 2001; Cleveland et al., 2002). Over 90% of the estimated 55,000 human deaths worldwide that occur yearly due to rabies are in Africa and Asia (Knobel et al., 2005). Yet, approximately 4 million people were reported to be bitten by dogs yearly in the United States of America, 1995-1996 (CDC, 1997). Thus, depending on how wounds are managed, fatality related to dog bite is known to occur as a result of rabies or tetanus complications (Monson, 1985, Lewis, 1995; Sacks, 1996; CDC, 1997).

In view of the civil war of 1989-2003, health care services and supervision of owned dogs were interrupted for about a decade and half in Liberia (Hatch et al., 2004; Kruk et al., 2010, 2011). Consequently the situation has been linked to a notable presence of stray dogs and rampant reports of dog bite injuries in humans by the local media. The situation has led to a call for humanitarian assistance for rabies control and prevention in Liberia by the Food and Agriculture Organization (FAO, 2008). Liberia had recorded annual cases of rabies since 1950 (Poindexter, 1953, Monson, 1985). In spite of these observations, there has been no reported study on the prevalence of dog bite cases and comprehensive report about the demography of dog bite victims in post conflict Liberia.

As a result this study was designed to review hospital records of dog bite cases in the country, 2008-2012, and to use it to predict rabies-like-illness in the country during the same period. One of the approaches to understanding the scale of human deaths due to rabies has been the use of probability tree model (Cleveland et al., 2002; Knobel et al., 2005). The approach was first designed based on a set of ten probability steps and used on active rabies surveillance data in Tanzania, with the distribution of bite injury on different body parts and the probability of developing rabies. The World Health Organization (WHO) has subsequently used the probability tree to estimate human deaths from rabies in Asia and Africa, providing credible figures on annual human rabies deaths based on empirical data.

The model has been used to estimate human rabies deaths in few developing tropical countries, including Bhutan (Tenzin et al., 2011), where passive surveillance data were used. In the current study, we report a passive survey of dog bite cases conducted countrywide, with active community-based surveillance in three counties of Liberia. The two main objectives of the study were to:

1) describe demographic characteristics of dog bite victims along age, gender and seasonal distribution pattern in Liberia, and;
2) estimate the number of human rabies-like-illness among dog bite victims, using a probability tree model.

Materials and Methods

Study location and duration
Liberia is located on the west coast of Africa, between longitude 7° 30' and 11° 30' west, and latitude 4° 8' and 8° 30' north
The study was conducted by a joint study group on rabies from Cuttington University (Liberia) and University of Ibadan (Nigeria) together with the Ministry of Health and Social Welfare, Liberia from November 2012 to April 2013. Community-based data gathering was conducted in three counties of Bong, Grand Bassa and Lofa. A transverse section across the north-south axis of Liberia is formed by the three counties. Lofa County in the extreme north-west of the country forms a boundary with Sierra Leone and Guinea, while Bong County in the central part of the country has a northern boundary with Guinea. Grand Bassa County in the west coast of the country is bounded on the south by the Atlantic Ocean. The three counties provide a cross-sectional area for dog bite survey in humans in Liberia.

Liberian national population census, 2008 estimated a total of 3,489,072 people in the country. The study areas has contributed 328,919 (Bong); 224,839 (Grand Bassa) and 270,114 (Lofa) to the national figure (LISGIS, 2008). Liberia has two main climatic seasons; the wet or rainy and the dry seasons. Rainy season starts in early April and ends in September or early October, while the dry season starts in October or November and ends in March (FAS, 1985; 2002).

Study Design
This was a retrospective review of records of patients who were dog bite victims, having sustained bite injuries between 2008 and 2012 country-wide in Liberia.

Figure 1: Study locations in Liberia, West Africa
Source: Centre for Control and Prevention of Zoonoses (CCPZ), University of Ibadan, Nigeria, 2013
Liberia. Epizootiological review of DBC records at Liberian Government Hospital (LGH), Buchanan; Phebe Hospital and Nursing School (PHNS), Suakoko; and Tellewoyan Memorial Hospital (TMH), Voinjama were made to identify suspected, probable and confirmed RLI cases. The age, gender, month and year of patient’s presentation and collection of specimens for laboratory confirmation where available were captured. Cases were selected and enlisted based on rabies case definition by the WHO (2004).

Seasonal distribution pattern was computed based on frequency of cases; the months of the year, categorized into rainy and dry seasons. Average percentage method that involves the expression of dog bite cases (DBC) and rabies-like-illness (RLI) as a percentage of the total over the 5 year period was used. Percentages for corresponding months (rainy and dry seasons) of different years were averaged.

**Rabies case definition**

Clinical case definition was based on World Health Organization description of a person presenting with an acute neurological syndrome (encephalitis) dominated by forms of hyperactivity (furious rabies) or paralytic syndromes (dumb rabies) progressing towards coma and death, usually by respiratory failure, within 7-10 days after the first symptom if no intensive care is instituted (WHO, 2004). A probable case was when a person displays clinical signs consistent with rabies though, not confirmed by laboratory but had appropriate exposure history (WHO, 2004).

A suspected case was when a patient that had signs compatible with the clinical case based on signs and symptoms of rabies patients and in dogs confined for 10 days after occurrence of incidence as defined (WHO, 2004). Rabies is considered endemic in Liberia; however, in-country laboratory capacity for confirmation of clinical diagnosis is non-existent. Since the diagnosis of a rabies case in Liberia was often based on clinical signs (clinical pathology) and the dogs involved were usually not confined for the prescribed 10 days, rather killed by mob action as soon as possible, especially in view of limited resources. This study thus uses the term rabies-like-illness in probable cases in view of this epizootiological situation.

**Data source**

The source of the primary data used in developing the Liberian dog bite geospatial observational data (LI-DB-GOLD) profile, 2008–2012 profile was from the Ministry of Health and Social Welfare, with inputs from the Ministry of Agriculture, Monrovia, Liberia. The LI-DB-GOLD was developed at the Center for Control and Prevention of Zoonoses, by a joint study group on DB from Cuttington University (Liberia), and the University of Ibadan (Nigeria), together with staff of the Ministry of Health and Social Welfare, and the Liberian Ministry of Agriculture, Monrovia. The dataset comprised all 491 cases of DB injury that were reported during the 5-year period, January 1, 2008 and December 31, 2012 countrywide. The site name of DB incidence was not usually available, but residential addresses of DB victim was available in most instances. The dataset was used for locating map points of DB.
Statistical analysis and modeling

A multivariate cross tabulation matrix was computed to display the frequency distribution of age, gender, and seasonal frequency of DB cases countrywide. Chi Square technique was used to analyse the relationship between frequency of occurrence of each of these categorical variables and DB pattern in Liberia, 2008-2012. Statistical significance was determined at $P<0.05$.

Human RLI and associated deaths were estimated from hospital records by computing a probability (decision tree) model designed by Cleaveland et al. 2002. A modified method for determining rabies recognition probability was used in this study in view of the absence of laboratory confirmation of rabies in Liberia before, during or after the war. Data were collected from the three hospitals and their neighboring towns and villages on the proportion of community suspect rabid dogs that were subsequently confirmed to produce clinical RLI in human victims of suspect rabid dog bite.

The decision tree model consists of 10 probability steps (P1 to P10). The first step P1 is the RLI recognition probability (the proportion of suspected rabid dog bites that are, in fact, RLI) (Tenzin et al., 2009). Based on the records, dog bite victims had no knowledge about the status of the biting dog (whether rabid or not) and no biting dogs were traced back to observe their rabies status. As a result, the disease status of the biting dogs was unknown. However, we used the proportion positive to RLI (based on physician’s clinical diagnosis) of rabies suspect dogs in the study areas for the period from 2008 to 2012. Community data on human deaths were obtained from Buchanan (Grand Bassa County), Gbarnga (Bong County), and Voinjama (Lofa County). Active investigation to determine RLI recognition ability of hospital personnel at LGH, PHNS and TMH was based on 30 suspect dogs selected across the study areas. Human death was determined through key informants and questionnaire survey. Only 19 of the 30 were confirmed with clinical human RLI cases among bite victims. RLI recognition probability (P1) was estimated to be 63% (0.63) for this study. At each probability step, dog bite injury data were classified according to the distribution of bites on different body parts: head/neck (P2); hand/arms (P3), trunk (P4), and legs/thigh (P5). Probability estimates on each body part were then calculated using the dog bite data (Tables 1).

Figure 2: Decision tree for determining the probability of rabies-like-illness following the bite of a suspect rabid dog
The probability of developing RLI following the bite of a rabid dog to the head (P6), arms (P7), trunk (P8) and legs (P9) were taken to be 45%, 28%, 5% and 5%, respectively as earlier reported in literature. (Cleaveland et al., 2002; Knobel et al., 2005; Tenzin et al., 2011). The probability of developing RLI was calculated with resultant death following a bite from a suspected rabid dog, $P_{RLI}$ from the statistical model:

$$P_{RLI} = P_1 \times \left( (P_2 \times P_6) + (P_3 \times P_7) + (P_4 \times P_8) + (P_5 \times P_9) \right) + (1 - P_{10})$$

Where:

- $P_{RLI}$ = Probability of developing rabies-like-illness from dog bite
- $P_1$ = Probability of suspected rabid dog being rabid
- $P_2$ = Probability of bite injury to the head
- $P_3$ = Probability of bite injury to the arm
- $P_4$ = Probability of bite injury to the trunk
- $P_5$ = Probability of bite injury to the legs
- $P_6$ = Probability of developing rabies-like-illness following bite injury to the head
- $P_7$ = Probability of developing rabies-like-illness following bite injury to the arm
- $P_8$ = Probability of developing rabies-like-illness following bite injury to the trunk
- $P_9$ = Probability of developing rabies-like-illness following bite injury to the legs
- $P_{10}$ = Probability of receiving post-exposure treatment if bitten by a suspected rabid dog

If the incidence of suspected rabid dog bites per 100,000 per year is $i$ and the population at risk is $Q$, then the total number of rabies-like-illness per year is given by $(i \times Q \times P_{RLI})/100,000$.

## Results

Some 488 dog bite cases were presented for treatment at the LGH, PHNS and TMH over the 5-year period, 2008-2012. (Table 1). One hundred and fifty (30.74%) of these cases were among children, ages 1-10 years old. Age group 11-20 years old was 108 (22.13%), age 21-30 years old was 51 (10.45%). Least was 31 (6.35%) cases among individuals over 51 years of age (Table 2). There was a significant difference between the two genders ($p < 0.05$) only among children.

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### Table 1:

<table>
<thead>
<tr>
<th>Year</th>
<th>Head $n$ (%)</th>
<th>Hand $n$ (%)</th>
<th>Trunk $n$ (%)</th>
<th>Leg $n$ (%)</th>
<th>Total $n$ (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>1 (0.2)</td>
<td>8 (1.6)</td>
<td>1 (0.2)</td>
<td>8 (1.6)</td>
<td>18 (3.7)</td>
</tr>
<tr>
<td>2009</td>
<td>2 (0.4)</td>
<td>18 (3.7)</td>
<td>2 (0.4)</td>
<td>14 (2.9)</td>
<td>36 (7.4)</td>
</tr>
<tr>
<td>2010</td>
<td>12 (2.5)</td>
<td>71 (14.5)</td>
<td>13 (2.7)</td>
<td>68 (13.9)</td>
<td>164 (33.6)</td>
</tr>
<tr>
<td>2011</td>
<td>13 (2.7)</td>
<td>72 (14.8)</td>
<td>11 (2.3)</td>
<td>66 (13.5)</td>
<td>162 (33.2)</td>
</tr>
<tr>
<td>2012</td>
<td>8 (1.6)</td>
<td>56 (11.5)</td>
<td>9 (2.0)</td>
<td>35 (7.2)</td>
<td>108 (22.1)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>36 (7.4)</strong></td>
<td><strong>225 (46.1)</strong></td>
<td><strong>36 (7.4)</strong></td>
<td><strong>191 (39.1)</strong></td>
<td><strong>488 (100.0)</strong></td>
</tr>
</tbody>
</table>

* Hospital and community-based data capture
Table 2:
Age distribution of dog-bite victims in Bong, Grand Bassa and Lofa counties, Liberia, 2008-2012

<table>
<thead>
<tr>
<th>Age</th>
<th>Female</th>
<th>Male</th>
<th>Total n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-10</td>
<td>59</td>
<td>91</td>
<td>150 (30.74)</td>
</tr>
<tr>
<td>11-20</td>
<td>43</td>
<td>65</td>
<td>108 (22.13)</td>
</tr>
<tr>
<td>21-30</td>
<td>25</td>
<td>26</td>
<td>51 (10.45)</td>
</tr>
<tr>
<td>31-40</td>
<td>24</td>
<td>18</td>
<td>42 (8.61)</td>
</tr>
<tr>
<td>41-50</td>
<td>25</td>
<td>23</td>
<td>48 (9.84)</td>
</tr>
<tr>
<td>Above 51</td>
<td>16</td>
<td>15</td>
<td>31 (6.35)</td>
</tr>
<tr>
<td>Unknown</td>
<td>-</td>
<td>-</td>
<td>58 (11.88)</td>
</tr>
<tr>
<td>Total</td>
<td>192</td>
<td>238</td>
<td>488 (100.00)</td>
</tr>
</tbody>
</table>

were more male (91, 60.7%) than female (59, 39.3%) involvement among children 1-10 years old.

DB case distribution was similar during the dry and wet seasons (Table 3). General treatments that were given in cases of DB was a wound wash with detergent in 48 (9.8%) cases. Anti-tetanus toxoid injection was given in some 167 (34.2%). Anti-rabies vaccine was given post exposure in about 145 doses to 89 victims (18.24%). Wound suture was done in 22 (4.5%) cases. No treatment was given in 38 (7.79%) cases. RLI estimation parameters derived from descriptive data on location of injury on victim were:

\[
P_1 = 0.63 \\
P_2 = 0.07 \\
P_3 = 0.46 \\
P_4 = 0.36 \\
P_5 = 0.39 \\
P_6 = 0.45 \\
P_7 = 0.28 \\
P_8 = 0.05 \\
P_9 = 0.05 \\
P_{10} = 0.3
\]

\[R_{RLI} = 0.83.\] The population at risk was 823,876 and total number of cases in each year from 2008 to 2012 was:

- 15 RLI in 2008
- 30 RLI in 2009
- 136 RLI in 2010
- 134 RLI in 2011
- 89 RLI in 2012

A total of 404 cases over the 5-year period.

Table 3:
Frequency distribution of dog-bite victims during the wet and dry seasons, Liberia, 2008-2012

<table>
<thead>
<tr>
<th>Season</th>
<th>Female</th>
<th>Male</th>
<th>Gender undocu-</th>
<th>Rabies-like-</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wet (April to September)</td>
<td>87</td>
<td>127</td>
<td>25</td>
<td>98 (41.00)</td>
<td>239</td>
</tr>
<tr>
<td>Dry (October to March)</td>
<td>108</td>
<td>112</td>
<td>29</td>
<td>99 (39.76)</td>
<td>249</td>
</tr>
<tr>
<td>Total</td>
<td>195</td>
<td>239</td>
<td>54</td>
<td>197 (40.37)</td>
<td>488</td>
</tr>
</tbody>
</table>
hospital records in 2008 and 2009 were gradually being re-introduced, the low number of cases could be attributed to limited passive surveillance records in the country at that earlier period.

The estimated 81 annual cases of human deaths due to RLI in 2008-2012 was a conservative assessment, which was based on a relatively new but weak passive surveillance system, with 3 out of 15 counties making contributions to the dataset. Data from Monrovia, the capital city, and its major and long established hospital services (Poindexter, 1953) were not included in this computation, which could have probably greatly increased the figures. There is therefore the need for prioritization of rabies detection, surveillance and effective control in the country.

Absence of pre- and post-exposure vaccination programme against rabies was notably high. Manson (1985) had earlier reported the same observation in 1985 following an outbreak of rabies in Zorzor district of Lofa County, Liberia. While the 1982 outbreak began within a major hospital premises and an urgent attention could be made to import anti-rabies vaccine, the situation in 2008-2012 was a different, being a humanitarian crisis (FAO, 2008) period. Some 145 doses indicated as used were on few individuals with several others receiving only one dose.

The estimated 81 annual cases of human deaths due to RLI in 2008-2012 was a conservative assessment, which was based on a relatively new but weak passive surveillance system, with 3 out of 15 counties making contributions to the dataset. Data from Monrovia, the capital city, and its major and long established hospital services (Poindexter, 1953) were not included in this computation, which could have probably greatly increased the figures. There is therefore the need for prioritization of rabies detection, surveillance and effective control in the country.

Discussions and Conclusion

An epizootiological review of records on dog bite cases in three county hospitals was conducted in this study and used to predict annual incidence of rabies-like-illness among humans in Liberia during the post conflict period, 2008-2012. Over the 5-year period, there were 488 cases of dog bite presented for treatment at the hospitals and 404 of these cases were estimated to have probably progressed to RLI, indicating an uncontrolled epidemic of the disease. Presence of all reported cases in three counties out of fifteen in the country may strongly indicate that passive surveillance was weak or non-existent in the other twelve counties during the 5-year period. This situation was quite explainable in view of the limited health facilities across the country in the immediate post civil crisis period (Kruk et al., 2010 and 2011).

The number of DBC in 2008 and 2009 were very low compared to those of 2010 and 2011. While this may be actual incidence in those years, it was most likely to be a reflection of the gradual restoration of health services across the country, as hospital and clinical facilities earlier destroyed were gradually reconstructed, as exemplified by the TMH in 2008 (SDC, 2008). Healthcare seeking behaviour was thus, more towards indigenous practices than orthodox medicine, during and just after the war (Kruk et al., 2010 and 2011). Since
The RLI outbreak in 2010 was consistent with pattern of rabies epidemics in West Africa, as earlier report in neighbouring Sierra Leone (Hatch et al., 2004) and Nigeria (Olugasa et al., 2009). A typical finding in West Africa on neglect of rabies control is the presence of stray dogs on streets, with complete absence of veterinary care, including anti-rabies vaccination programme (Olugasa et al., 2011b). An organized joint study programme to determine dog population, their distribution, use and management practices and the implications for rabies control in post-conflict Liberia may be helpful in adequately planning towards the control of rabies and RLI in the country. Such practice has been earlier reported and found useful in Nigeria (Aiyedun and Olugasa, 2012a).

By engaging current efforts at ensuring Excellence in Higher Education for Liberian Development (EHELD) programme (CU, 2012), the prioritization of dog population census for its management as human companion may enhance inclusive learning about human-animal diseases in Liberia on a long term basis (Olugasa et al., 2011a; 2012). This initiative (Olugasa and Fasunla, 2012) may engage college students in nursing and agriculture programmes to promote rabies surveillance and control as part of national health development education.

The present study had some inherent limitations, which includes the absence of a confirmatory laboratory diagnosis of rabies. Thus, the use of rabies-like-illness, in spite of clinical case conformity with WHO clinical case definition. A veterinary diagnostic laboratory exists by the University of Liberia, Fendel Campus, near Monrovia, the capital city, but there were no laboratory workers to operate it. There were often no materials to conduct relevant tests, such as the Fluorescent Antigen Test for rabies virus (MoA, personal communication). The Food and Agriculture Organization had hired experts to train some Liberians to diagnose some other diseases, including Newcastle, Pest des Petites Ruminants and avian influenza, but not rabies. There is a need to conduct an active surveillance of rabies and rabies related viruses in Liberia with laboratory confirmation to re-evaluate some of the parameters of the decision tree, in order to conform with the conventional approach. Such effort is in addressing sub-regional one-health challenges (Olugasa and Fasunla, 2013).

In view of inherent cold-chain maintenance challenge in the country following extensive damage to infrastructures, including road networks, the possible adverse affect on vaccine delivery on the field needs to be planned for in any humanitarian intervention for vaccine supply. Antibody levels agent rabies among at risk individuals, as well as among confined, free-roaring and stray dogs need to be monitored along vaccination exercise to evaluate sero-conversion in the population. By working with other West African National Laboratories that produce rabies vaccine, such as the National Veterinary Research Institute (NVRI), Nigeria (Tekki et al., 2013), some adequate number of vaccines for dogs may be deployed for a mass anti-rabies vaccination programme on humanitarian and educational (Olugasa et al., 2011a; 2012) outreach activities.
Based on existing joint study programmes between the two Universities, a community outreach programme on antirabies vaccination for dogs and post-exposure prophylaxis for humans was being proposed between Cuttington University (Liberia) College of Nursing and Allied Health Sciences and the University of Ibadan (Nigeria), Faculty of Veterinary Medicine / College of Medicine (Olugasa et al., 2011a; Olugasa and Fasunla 2013). The aim of the programme was to contribute to the much needed humanitarian assistance and capacity building to reduce the annual human and animal deaths in Liberia.

Conclusion

Dog bite injury with its associated human deaths remains a major public health challenge in Liberia. A conservative 81 average annual human deaths was estimated due to rabies-like-illness in the country was estimated in this study. This finding, to our knowledge provides an empirical data and information on the disease in post-conflict, 2008-2012.

There FAO observation of a humanitarian crisis with reference to rabies remains a major situation in the country. All ages and genders were at risk. However, children less than 10 years of age and youth between 11 and 20 were most involved, with inadequate post-exposure treatment. There is need for short and long term education of the public to engage in active participation in the control and prevention of the disease. Especially through Excellence in Higher Education for Liberian Development.

Acknowledgment

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References


Jomah ND, Ososanya TO, Mulbah CK and Olugasa BO

Dog bite cases and rabies-like-illness among humans in Liberia, 2008-2012


LISGIS (2008). National population and housing census results. Liberian Institute of Statistics and Geoinformatics Services; 23p


