Short note

UNIVERSITY OF NAIROBI
College of Agriculture & Veterinary Sciences
Faculty of Veterinary Medicine
May 17, 2019

Coronaviruses from Bats in Laikipia County, Kenya and their Implications on Human and Animal Health

By Dr. Rimfa Amos Gambo, DVM, MSc

INTRODUCTION

There is a global rise in outbreaks of coronavirus infections resulting in high morbidity and mortality rates among humans and animals. Bats which are widely distributed, have capability of flight and are the second largest group of mammalian species are natural reservoirs of these viruses. Coronaviruses are viruses that typically affect the respiratory tract and gut of mammals and birds, causing important diseases. In animals, these viruses include the porcine epidemic diarrhoea virus (PEDv) and porcine delta-coronavirus (PDCoV) in pigs and infectious bronchitis virus (IBV) and turkey coronavirus in poultry. In humans, coronaviruses causing diseases include the common cold virus, severe acute respiratory syndrome coronavirus (SARS-CoV) and Middle East respiratory syndrome

ABOUT THE AUTHOR

Dr. Rimfa Amos Gambo has just completed his postgraduate training for an MSc degree in Wildlife Health and Management in the Faculty of Veterinary Medicine, University of Nairobi. He holds a DVM degree from Ahmadu Bello University, Nigeria. His MSc thesis research work, from which this Policy Brief has emanated, was supervised by Prof. George K. Gitau, a Professor of Veterinary Medicine in the Department of Clinical Studies, Dr. Joseph Kamau, a Senior Lecturer in the Department of Biochemistry, specializing in Molecular Biology and Dr. Andrew Thaiyah of USAID.

coronavirus (MERS-CoV). SARS was linked to marketplace Himalayan palm civets (*Paguma larvata*), bats[1] and racoon dogs (*Nyctereutes procyonoides*) while MERS originated in bats.[2] Both SARS and MERS showed similar clinical symptoms such as cough, dyspnea and pneumonia but advanced cases of MERS appear with clinical renal failure. Outbreaks of coronaviruses spread like wild bush-fire affecting people from different nationalities and color. It is important to understand the origin of coronaviruses infecting humans and animals, for purposes of prediction and prevention of pandemic emergence in the future. In Figure 1, Kenya appears among countries rich in biodiversity and consequently, a "hotspot" for emergence of new diseases.
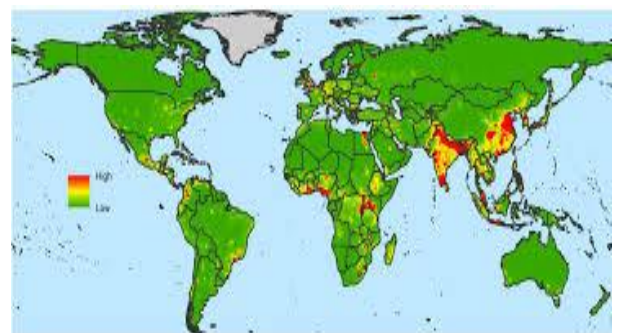

Figure 1: Predicted heat map showing relative risk of zoonotic Emerging Infectious Diseases (EID) events. Red is the highest, yellow mid-level risk, green indicates lowest risk. Kenya falls among regions of high risk EID events.[3]

ECONOMIC CONSEQUENCES OF CORONAVIRUSES OUTBREAKS

Bats are reservoirs of coronaviruses and do not show clinical disease. Containing epidemics from coronaviruses spillover from bats can be very expensive due to the high morbidity and mortality rates.

The occurrence of porcine epidemic diarrhea in 2013 in the United States resulted in a mortality rate of about 100% in affected piglets[4] and approximately 10% of America's pig population was lost in just a year with an estimated net annual decrease for U.S. economic welfare from $900 million to $1.8 billion. Severe acute respiratory syndrome coronavirus (SARS-CoV) infected 8,000 people from different continents of the world regardless of color and race with a mortality rate of 10%. In addition to the impact of SARS-CoV on infected individuals and the global community, the economic cost of the SARS- CoV outbreak event was estimated at $16 billion[3]. Middle East Respiratory Syndrome Coronavirus (MERS-CoV) in Saudi-Arabia infecting more than 1,700 people with mortality rate of 35%[5].

With the isolation of novel coronaviruses in bats in Laikipia County, the 46.9% sero- prevalence of MERS-CoVs in camels in that region[6], and considering the economic implication of coronavirus outbreaks, full evaluation of these viruses needs to be carried out.

STUDY ON CORONAVIRUSES IN LAIKIPIA COUNTY, KENYA

A study was carried out to determine the presence and genetic identity of coronaviruses in bats in Laikipia County, Kenya. A total of two hundred and two (202) bats from the county were trapped and sampled in September, 2017 (dry season) and May, 2018 (wet season). Oral and rectal swabs were collected from all 202 bats and placed in cryovials containing trizol and preserved in liquid nitrogen for transportation to the Institute of Primate Research (IPR) laboratories. The samples were afterward transported to $-80^{\circ}C$ in the laboratories.

RNA was extracted from all samples and cDNA prepared using superscript III (Invitrogen). To increase the chances of detecting both known and novel coronaviruses (CoVs), two consensus PCR assays[7,8,9] targeting non-overlapping fragments of the orf1ab were used. All the positive samples were then cut, gel purified and sequenced.

Table 1 shows the distribution of samples from bats in Laikipia, County according to the species, age and sex of bats and the number of samples that were positive for coronaviruses. Eight out of the 202 bats examined (4%) were positive for coronaviruses.

Figure 2 shows bats' nests and fecal smears on walls, doors and ceiling in buildings in the study area.

Table 1: Summary of data for 202 bats sampled for coronaviruses in Laikipia County, Kenya

Species of bats	No. sampled	Pos	F	A	SA	Ju	L	G	OS	RS
Chaerephon sp.	188	6	111	173	24	7	0	3	188	188
Scotophilus sp.	14	2	8	10	1	2	0	0	14	14

Key: Sp= Species; Pos= Positive; F= Female; A= Adult; SA= Sub-adult; Ju= Juvenile;
L= Lactating; G= Gravid; OS= Oral swabs; RS= Rectal swabs

Figure 2: Bats' nests and fecal smears on walls and doors (a) and nests in a restaurant (b) in Laikipia County, Kenya in 2017. The nests and fecal smears are indicated by arrows.

Phylogenetic analysis of the sequenced products with reference sequences from the genbank showed all isolates belonged to unclassified alpha coronaviruses. Five of the viruses were distant relatives of Kenyan bat-coronaviruses, formed a monophyletic group indicating they are new strains of the virus. Three formed cladistic relationships with Kenyan bat-coronaviruses from the database.

A behavioral study was conducted to assess the interaction of the people with food, water and animals at the human-wildlife-livestock interface. Figure 3 shows the interactions recorded in the study. A total of 156 individuals participated in the survey, ranging in age from 12-84. Sixty three [63 (40%)] were males and of 121 adults interviewed, 48 (40%) had received no formal education. Among the participants, 151 (97%) reported raising livestock in the last year, and a similar number reported handling live animals within the last year. The majority (67%) of respondents sourced drinking water from unimproved water sources, and 115 (74%) shared their drinking water with animals. Fifty-two percent of respondents reported eating a sick animal in the previous year, and 44% reported consuming meat from an animal found dead. Seventy-eight (50%) of respondents reported eating meat from a sick goat and 49 (31%) reported eating sick cattle during the preceding year.

Additional analysis is ongoing, and serum samples are still undergoing testing. These initial findings reveal a highly complex human-wildlife-livestock interface in Laikipia County, Kenya. The risk of disease transmission is heightened due to high human-animal interaction and high-risk food practices, such as consuming sick animals or collecting animals found dead. Although respondents were concerned about disease transmission, safe practices in water, food, and animal handling to decrease risk were not commonly used. Further research of community perceptions can inform culturally appropriate means of improving food safety practices.
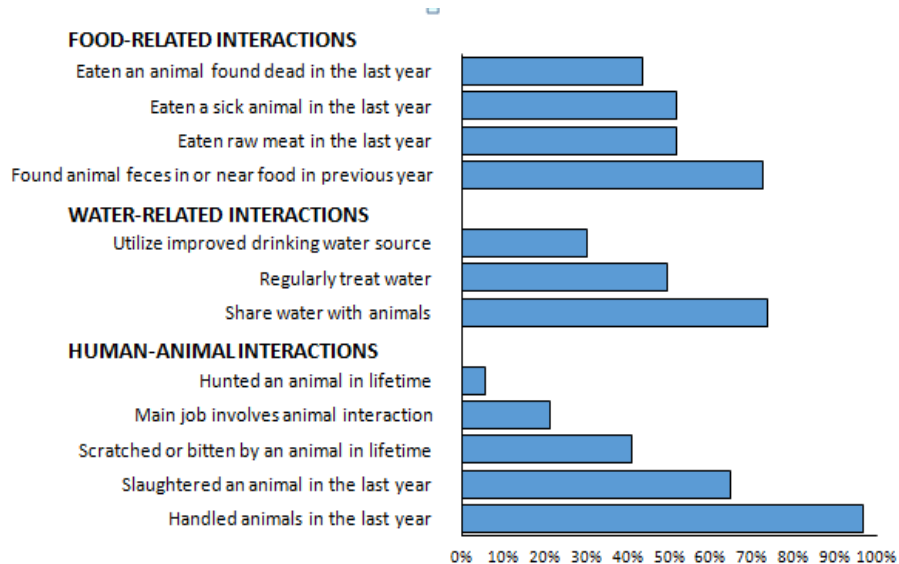
Figure 3: The food related, water related and human-animal interactions recorded in Laikipia County, Kenya in 2017[10].

RECOMMENDATIONS

1. A full genome analysis is recommended to characterize the five new coronaviruses detected in the bat samples in this study and to determine their implication on human health.

2. For future studies in bats, sampling should target oral swabs rather than rectal swabs, and the wet season rather than the dry season.

3. Bats eat insects such as moths and beetles that damage crops. They also play an important role in pollinating flowering plants and aid in seed dispersal. Over 300 species of fruit producing plants including mangoes, bananas, and guavas depend on bats for pollination. It is therefore important that bats are protected.

4. The best way to live safely with bats is to avoid all contact with both living and dead bats and to prevent them from roosting in food stores and premises inhabited by humans such as homes, restaurants, offices and clinics.

5. No attempt should be made to save or eat food that has been partially eaten by bats by removing the sections with obvious bite marks. Such food should also not be fed to animals.

6. If one touches a dead bat with bare hands, they should wash their hands with soap and running water. A disinfectant that can kill viruses, such as hand sanitizer gel or wipes should be used where available.

MANAGING BATS IN THE HOMES

There are many kinds of bats that live around villages or in cities. Most bats that would live inside buildings or houses are small and usually eat insects. Normally, bats are harmless and will not bite or scratch people if left alone. To manage bats in homes and prevent human and animal exposure to infections, the following can be done[11]:

1 Because some bats with disease causing organisms may appear normal, direct contact with all bats and their body fluids should always be avoided as a preventive measure.

2 Bats may be attracted to uncovered sources of water and other liquids. When bats drink from these sources, they contaminate them with their saliva, urine, or feces. To prevent bats from being drawn to liquids, water or foods in homes, such liquids should always be securely covered and the covers regularly cleaned.

3 The most effective method for preventing bats from entering a building or house is to make sure that there are no holes or extra spaces around doors, windows, ceiling, and roof where they can enter. Tightly placed screens or wire mesh can be used to cover windows and doors.

4 All people including children should be informed why it is important not to touch, play with, or kill bats. Children should be especially discouraged from touching sick or dead bats. Live bats found on the ground are likely to be sick or hurt, and can be a source of infection. One should avoid directly touching live or sick bats with ungloved hands.

REFERENCES

1 Guan, Y., Zheng, B. J., He, Y. Q., Liu, X. L., Zhuang, Z. X., Cheung, C. L., and Butt, K. M. (2003). Isolation and characterization of viruses related to the SARS coronavirus from animals in southern China. *Science*, *302*(5643), 276-278.

2 De Benedictis, P., Marciano, S., Scaravelli, D., Priori, P., Zecchin, B., Capua, I. and Cattoli, G. (2014). Alpha and lineage C betaCoV infections in Italian bats. *Virus genes*, *48*(2), 366-371

3 Jones, K. E., Patel, N. G., Levy, M. A., Storeygard, A., Balk, D., Gittleman, J. L. and Daszak, P. (2008). Global trends in emerging infectious iseases. *Nature*, *451*(7181), 990.

4 Stevenson, G. W., Hoang, H., Schwartz, K. J., Burrough, E. R., Sun, D., Madson, D., and Koster, L. G. (2013). Emergence of porcine epidemic diarrhea virus in the United States: clinical signs, lesions, and viral genomic sequences. *Journal of veterinary diagnostic investigation*, *25*(5), 649-654.

5 WHO (2019. Middle East respiratory syndrome coronavirus (MERS-CoV). http://www.who.int>News>facts sheet

6 Deem SL, Fèvre EM, Kinnaird M, Browne AS, Muloi D, Godeke G-J, et al. (2015) Serological Evidence of MERS-CoV Antibodies in Dromedary Camels (*Camelus dromedaries*) in Laikipia County, Kenya. PLoS ONE 10(10): e0140125. https://doi.org/10.1371/ journal.pone.0140125

7 Anthony, S. J., Johnson, C. K., Greig, D. J., Kramer, S., Che, X., Wells, H., and Karesh, W. (2017). Global patterns in coronavirus diversity. *Virus evolution*, *3*(1).

8 Quan, P. L., Firth, C., Street, C., Henriquez, J. A., Petrosov, A., Tashmukhamedova, A., and Ogunkoya, A. B. (2010). Identification of a severe acute respiratory syndrome coronavirus-like virus in a leaf-nosed bat in Nigeria. *MBio*, *1*(4), e00208-10.

9 Watanabe, S., Masangkay, J. S., Nagata, N., Morikawa, S., Mizutani, T., Fukushi, S., and Taniguchi, S. (2010). Bat coronaviruses and experimental infection of bats, the Philippines. *Emerging infectious diseases*, *16*(8), 1217.

10 Joseph Kamau., Allan Kwallah., Peris Ambala., Elizabeth Ashby., Megan Vodzak., Suzan Murray., Dawn Zimmerman. and Lindsey McCrickard Shields (2017). Analyzing human behaviors that increase risk of zoonotic disease transmission in Laikipia County, Kenya (Unpublished data).

11 Leilani Francisco, Ava Sullivan, Jonathan Goley, Stephanie Martinez (2018). Living safely with bats; an educational handbook. https://www.ecohealthalliance.org/wp-content/uploads/2018/10/

ACKNOWLEDGEMENTS