Investigation and Control of Rabies Outbreak at Orong Geog and adjoining areas in Samdrup Jongkhar

Dr. Tenzin, PhD
Dy Chief Veterinary Officer
(Veterinary Epidemiologist)
Disease Prevention and Control Unit
National Centre for Animal Health
Department of Livestock, Thimphu
E-mail: tenzinvp@gmail.com

Summary

This report describes the investigation, findings and response of a rabies outbreak in Orong, Narphung and Samdrup Jongkhar town under Samdrup Jongkhar Dzongkhag, south eastern Bhutan with onsets of outbreaks from December 2015 through January 04, 2016.

In early December 2015, there was a report of unusual stray dog mortality at Orong Higher Secondary School (OHSS) campus and was initially suspected for cold stress or canine parvovirus infection. A school girl from Malang village, south of OHSS adopted one stray dog (pup) from the vicinity of OHSS area which later showed abnormal signs, bitten four people and then died on 12/12/2015. The brain tissue was tested negative by anigen rapid rabies antigen test conducted in the field on 13/12/2015 but was confirmed positive to rabies virus at National Center for Animal Health, Serbithang by FAT on 12/1/2016. As an interim measure (before the disease was confirmed as rabies at NCAH), the NCAH advised SVL Deothang and RNR-EC Orong to keep vigilant and monitor the situation.

Later a JX calf which was bitten by a pet dog on 15/12/2015 showed aggressive behavior and died on 11/01/2016; the brain tissue was tested positive to rabies. The RLDC, Khangma was informed about the possible outbreak of rabies in Orong and advised to conduct investigation. The Public Health Department, MoH was also informed about rabies outbreak in Orong and advised them to share information with the Dzongkhag Health officials, Samdrup Jongkhar for preventive measures and investigation. A joint investigation was conducted by RLDC Khangma, SVI Deothang, DVH S/Jongkhar, Dzongkhag hospital Samdrup Jongkhar and RNREC & BHU Orong on 15/1/2016. Based on the investigation report, Dr. Tenzin, Head DPCU, NCAH visited Orong geog on 20/1/2016 and lead a Rapid Response Team (RRT) to further investigate the source of outbreak and coordinate containment of disease outbreak. The team have re-investigated the outbreak and tentatively identified the source of outbreak through movement of rabid dog from the border town (Samdrup Jongkhar). The team also attended two clinical cases of rabies (one calf at Orong and one stray dog at Narphung), both tested positive to rabies. A total of 2 calves and 4 dogs (1 pet) were confirmed rabies by laboratory test whilst one calf and few stray dogs were suspected to have died of rabies. One hundred and eleven people were given rabies postexposure prophylaxis; four for confirmed rabid dog bite injury, 37 for dog and cat bites (suspected rabid dog bite) and 74 people for consumption of milk and dairy products.

The RRT have vaccinated 211 dogs and 171 cats in all the villages under Orong Geog and also along the national highway (between Narphung and Arong) by creating eight temporary vaccination points to create immune buffer and prevent the spread of outbreak. The public were made aware on rabies and its impacts on animals and human health, and importance of public support for prevention and control. The economic impact of this outbreak was estimated to be Nu.2,59,703. The disease is under control and no more new cases have been reported since January 4, 2016.
1. Background

1.1. Geog information

Orong geog (179.03 Sq.Km) is situated 62 km north of Samdrup Jongkhar town including a 12 km farm road bifurcating at a place called Shekpashing from the national highway which connects Samdrup Jongkhar and Trashigang. Orong geog has 24 villages, six chiwogs (Orong, Wooling, Morong, Jangchubling, Rimung and Pheluma) with a total of 485 households and 4686 people. The government infrastructures in Orong includes four schools (Orong Higher secondary school, Orong Lower secondary school, Wooling Community primary school and Pheluma ECR), Basic Health Unit and RNR-EC.

Fig 1: Bhutan map showing the Samdrup Jongkhar Dzongkhag & Orong Geog with 6 Chiwogs of Orong geog (inset). The red line is the national highway in the country.

Fig 2: View of Orong geog and villages from Arong (Red circle indicate the rabies outbreak areas)
Fig 3: Wooling village (one of the Chiwogs under Orong geog)

Fig 4: Narphung (situated about 67 km north of S/Jongkhar town). The half part of the area (right side) is under Orong geog and the other half (left side) is under Gomdar geog.
1.2. History of rabies outbreaks

Deothang and Langchenphu (Jomotshangkha area) geog in Samdrup Jongkhar reports frequent outbreak of rabies in dogs and spillover infection in cattle. For instance, between 1997 and 2015, Deothang geog reported 25 outbreaks of rabies (outbreak reported each year except in 2014). The outbreak occurred mainly in Deothang town area (n=17 outbreaks) with a few instances in S/Jongkhar town (n=8 outbreaks). Orong and Narphung recorded rabies outbreak in dogs and spillover infection to cattle and horses in 2002 and 2003. The cases were detected in Morong (Athayi-18 KM from Deothang) along the national highway, Narphung town and Orong village. Since then there was no history of any reported rabies cases in dogs or in domestic livestock in Orong.

However, in the second week of December 2015, an unusual stray dogs mortality was reported at Orong Higher Secondary School (OHSS) campus (before the start of the winter vacation). The cases were initially suspected to be due to cold stress or canine parvovirus infection. Approximately 10 dogs have died, but no samples were collected. Interestingly, a rabies suspected case of a Jersy cross calf (4 months of age) was reported at Dawathang village in Langchenphu geog on 20/11/2015. The calf died on 25/11/2015 and the brain tissue tested positive to rabies virus. The calf along with the dam (cow) was taken from Wooling-Manthar village under Orong Geog on 14/11/15. It is unknown whether this case is linked to rabies outbreak in Orong or a separate case in Langchenphu. Langchenphu also reports sporadic cases of rabies. However, looking at the short interval between arrival at Dawathang and onset of clinical symptoms of rabies (about one week), it appears that it is linked with rabies outbreak in Orong geog (see recommendation no. 6). However, rabies outbreak was not confirmed in Orong at the time of investigation in Dawathang. During awareness meeting, the public have reported stray dog deaths in Wooling village in November 2015, suggesting that rabies cases in stray dogs have been occurring in Wooling village earlier than Orong. Wooling is about 10 Km from Orong.

Following the first rabies suspected outbreak investigation submitted by SVL Deothang and verbal report of unusual dog deaths in Orong by the Livestock extension official, the NCAH provided technical advice to conduct investigation and monitor the situation closely. The RLDC-Khangma was advised to lead a detailed investigation in coordination with Samdrup Jongkhar Dzongkhag Health officials and other relevant stakeholders. The following team conducted public meeting at Orong on 15/01/2016 and created awareness on rabies.

1. Dr. Sangay Letho, Sr. Veterinary Officer, Regional Livestock Development Center, Khangma
2. Dr. Kezang Wangdi, Medical Officer, Dzongkhag Hospital, Samdrup Jongkhar
3. Dr. Karma Phuntshok, Veterinary Officer, Dzongkhag Veterinary Hospital, Samdrup Jongkhar
4. Tshewang, Livestock Extension Officer, Dzongkhag Veterinary Hospital, Samdrup Jongkhar
5. Tshewang Rabgay, Laboratory Technician, Satellite Veterinary Laboratory, Deothang
6. Nima, Health Assistant, BHU, Orong geog
7. Yeshey Wangpo, Livestock Extension Officer, Orong geog

Fig 5: Public meeting at Orong conducted by joint investigation team on 15/01/2016
Based on the investigation report submitted by the team and also based on the severity and public health importance of rabies, Dr. Tenzin, Head, Disease Prevention and Control Unit (DPCU), NCAH was directed to further re-investigate the source of outbreak and coordinate containment of outbreak (vide order No. 3(6)NCAH/Adm/2015-2016/601 dated 19 January 2016). The team visited Orong on 20/1/2016 and formed the following Rapid Response Team (RRT) to coordinate containment of outbreaks.

1. Dr. Tenzin, Dy. Chief Veterinary Officer, DPCU, NCAH, Serbithang (Team leader)
2. Dr. Karma Phuntshok, Veterinary Officer, DVH, Samdrup Jongkhar
3. Mr. Tshewang, Livestock Extension Officer, DVH, Samdrup Jongkhar
4. Mr. Tshewang Rabgay, Lab. Technician, Satellite Veterinary Laboratory, Deothang
5. Mr. Yeshey Wangpo, Livestock Extension Officer, Orong geog
6. Mr. Karma, Animal Welfare Officer, NDPM&RCP, NCAH, Serbithang
7. Mr. Tshewang, Driver, NCAH, Serbithang (logistic support)

The following case history provide a detailed information related to rabies outbreak in Orong, Narphung and Samdrup Jongkhar town between December 10, 2015 and February 4, 2016.

**Case 1:** A school girl from Malang village (about 30 minutes walk south of Orong HSS) adopted one stray dog (3 month old pup) from the vicinity of OHSS area on 10/12/2015. The dog showed abnormal signs such as barking and has bitten four people, and then died on 11/12/2015. The SVL Deothang conducted postmortem examination on 12/12/2015 and the brain tissue tested negative to rabies using anigen rapid rabies antigen test. However, the sample was referred to NCAH and confirmed positive to rabies virus by fluorescent antibody test (FAT) on 12/1/2016. All the exposed person received full course of rabies PEP from Orong BHU. The SVL & Orong Livestock in-charge were informed by NCAH to monitor the situation and update the disease status regularly.

**Case 2:** A Jersy cross calf (female, 7 months) in Thongsa village was bitten by stray dog on 12/12/2015. The calf showed abnormal signs (salivation, bellowing, anorexia) on 28/12/2015 and died on 11/1/2016. The carcass was buried and not tested against rabies. The stray dog that had bitten the calf was also seen dead, but the sample was not collected for testing against rabies.

**Case 3:** A Jersy cross calf (male, 7 months of age) of Gonpa village was bitten by a pet dog (owner’s dog) on ear on 15/12/2015. The calf showed salivation and abnormal signs on 8/1/2016 and then died on 11/1/2016. The postmortem examination was conducted on 12/01/2016 by SVL Deothang and the brain tissue tested positive to rabies virus by rapid rabies antigen test. The rabies was also confirmed by FAT at NCAH on 4/2/2016. Although the dam (milking Jersy cow) was not bitten by dog (not observed by the owner), there was apprehension that the rabid calf might have transmitted the virus while suckling. Many people were given PEP course since they have consumed milk and dairy product from this cow. The cow was found to be apparently healthy at the time of RRT visit on 21/01/2016. The cow is being given post-exposure rabies vaccination and advised RNREC, In-charge Orong to follow day 0,3,7,14,28 schedule, but cautioned owner to isolate the cow even though the history of dog bite is unknown (see lessons learned section below).

**Case 4:** A Jersy cross calf (male, 6 month) of Gonpa village (neighbour to Case no 3) was bitten by same pet dog of Case No. 3 on the nostril on 16/12/2015. The animal showed clinical signs of rabies (salivation, frequent bellowing, fits) on 17/01/2016 and died on 22/01/2016. The case was investigated by RRT on
20/1/2016 and 21/01/2016 (before death) and rabies was suspected based on the clinical symptoms observed. The postmortem examination was conducted on 23/01/2016 by RRT and the brain tissue tested positive to rabies virus by rapid antigen detection test. The rabies was also confirmed by FAT at NCAH on 28/01/2016.

A high yielding milking cow (Jersey cow), dam of this calf was also observed to have been bitten by the same pet dog on leg on 16/12/2015. The cow was found to be apparently healthy at the time of RRT visit on 21/01/2016. The cow is being given post-exposure rabies vaccination and advised LEC In-charge Orong to follow day 0,3,7,14,28 schedule, but cautioned owner to isolate the cow and report if she shows any abnormal signs.

Similar to Case no. 3, many people have consumed milk and dairy product from this cow and were given PEP at Orong BHU (some at Deothang BHU) (see lessons learned section below).

**Case 5:** A history of aggressive female adult dog that had bitten three people at Narphung town was reported to the RRT and the dog died on 21/01/2016. The team visited Narphung and conducted postmortem examination on 23/01/2016. The brain sample was tested positive to rabies virus by rapid antigen detection test on 23/01/2016 and also by FAT at NCAH on 28/01/2016. The exposed person are undergoing PEP.

The residents in Narphung have observed that this dog had also bitten two other dogs in the town. The two suspected rabid dogs were captured using nets and kept under observation (strict isolation) and advised the town Tsokpa to monitor the health status of the dogs and report to In-charge RNREC, Orong (see Case 7 below).

**Case 6:** In the early morning (6.30 pm) on 27/01/2016, a rabies suspected dog (showing aggressive behavior) was found roaming/moving towards Deothang along the national highway at Charkilo area (4km from SJ) by the Dzongkhag Livestock team. As per the local informant, the dog was seen moving from Samdrup Jongkhar town area towards Deothang following the national highway. The dog was captured using net and kept in cage under observation at DVH, S/Jongkhar. The dog showed aggressive behavior (biting cages, stick, vocalisations) which are characteristics of furious rabies in dog. The dog died on 31/01/2016 and the brain tissue tested positive to rabies virus both by rapid antigen detection test and FAT.

**Case 7:** The stray dog (adult) which was bitten by rabid dog (Case 5 dog) and kept under isolation at Narphung town showed rabies symptoms and died on 04/02/2016 and was buried by people. The carcass was exhumed on 05/02/2016 and conducted postmortem examination. The brain tissue tested positive to rabies virus by rapid rabies antigen test conducted on 05/02/2016 and also by FAT on 11/02/2016.

**Case 8:** A 3 year old male dog (pet) was brought from Deothang Bangtsho to RICBL colony in Samdrup Jongkhar somewhere on 23/01/2016. The dog was sick and showed unusual behavior on 02/02/2016 and brought for examination at DVH, S/Jongkhar on 04/02/2016. The dog was kept under isolation (in cage at DVH) and died on the same day (04/02/2016). The brain tissue tested positive to rabies virus by rapid rabies antigen test and also by FAT at NCAH on 11/02/2016. The owners were advised to get PEP against rabies. The dog was kept outside the house both at Bangtso and in RICBL colony in Samdrup Jongkhar, but the owner have not noticed any bite by other dogs. It appears that the dog was bitten by rabid dog in Deothang or in S/Jongkhar. There could have been circulation of sporadic cases of rabies in dogs in Deothang.
3. Objectives of investigation

1. To identify the source and/or mode of transmission
2. To implement control measures and prevent further outbreak
3. To prevent further spread of outbreaks into other areas
4. To address public concerns through risk communication
5. To involve the public in disease control to institute ownership for disease control
6. To reduce direct and indirect costs of disease/outbreaks
7. To identify factors that contributed to the outbreak in order to develop strategies to prevent similar outbreaks in the future
8. To help guide disease prevention and control strategies in future
9. To advance research on rabies epidemiology and dog ecology

4. Possible scenario or hypotheses of rabies incursion into Orong & Narphung

The following scenarios were developed to investigate and identify the source and mode of rabies transmission and spread into Orong geog:

1. Movement of stray dogs infected with rabies virus (under incubation period) from the border town (Darrang-Samdrup Jongkhar border town) to Deothang and Orong along the national highway;
2. Adoption of stray dogs (possibly rabies virus infected dog under incubation period) from border town by the residents of Deothang, Orong and also the residents of labour camps along the national highway;
3. Translocation of stray dogs (possibly rabies virus infected dog but under incubation period) from the border towns and released along the Deothang-Narphung highway with subsequent movement to Orong;
4. Movement of pet dogs (possibly exposed to rabies) from S/Jongkhar border town along with owner to Orong;
5. Involvement of wildlife in the transmission of rabies

5. Methodology of Investigation and Rapid Response

5.1. Epidemiologic investigation

- The relevant stakeholders (RLDC-Khangma, SVL-Deothang, DLO/DVH-Samdrup Jongkhar, LEC-Orong; Geog officials) were informed about the detailed investigation plan including team composition and logistics through phone and e-mails prior to visiting Orong;
- The Geog officials were informed about the date and time of visit and directed to inform public to gather at Orong RNREC compound for meeting and also for mass dog vaccination program;
- The public meeting was conducted in the presence of Geog Mangmi and the time line of dog and cattle death events was verified and noted;
- The possible scenarios of rabies outbreaks in Orong was discussed during the meeting
- Separate interviews were conducted among the key informants, village leaders through field visit to the villages;
- The residents of labour camp, shops, restaurant and hotels along the highways were interviewed to understand the movement of stray dogs;
- The stray dogs movement along the national highway was verified through direction observation by repeated travel (in car) between Samdrup Jongkhar-Deothang-Narphung national highway on alternative days
- Orong BHU and Deothang hospital were visited and discussed with health officials on dog bite pattern and PEP procedure

The suspected rabies cases in dogs and cattle reported in Orong, Narphaung and S/Jongkhar town were categorized into following case classification:

**Suspect:** The animal demonstrating strange behavior progressing to aggression, disorientation, impaired mobility, unusual vocalizations, salivation, biting inanimate objects & people (in case of dogs), coma and death in Orong village, Narphung & Samdrup Jongkhar town in between November 2015 and January 2016.

**Confirmed:**
The animal demonstrating strange behavior progressing to aggression, disorientation, impaired mobility, unusual vocalizations, salivation, biting inanimate objects & people (in case of dogs), coma and death in Orong village, Narphung & Samdrup Jongkhar town in between November 2015 and January 2016. Detection of rabies virus in brain tissue by Anigen Rapid Rabies Ag test and by fluorescent antibody test (FAT) at NCAH.

### 5.2. Clinical & laboratory investigation

1. A calf (jersey cross, male, 7 month) which was bitten by rabid dog on nostril area on 16/12/2015 showed clinical signs of rabies (salivation, frequent bellowing, fits) on 17/1/2016 and then died on 23/01/2016. The RRT investigated the case and the brain tissue tested positive to rabies by Anigen Rapid Rabies Ag test in the field and also by fluorescent antibody test (FAT) at NCAH on 28/01/2016.
2. A stray dog (female, adult) in Narphung town area became furious and had bitten three people. The dog died on 21/01/2016 and the brain tissue was collected and tested positive to rabies virus both by rapid rabies Ag test & by FAT on 23/01/2016.
3. A stray dog which was bitten by confirmed rabid dog in Narphung showed mild clinical signs (disorientation) suspecting rabies at the time of RRT visit. The dog was captured using net and kept under strict isolation. The dog died on 04/02/2016 and the brain tissue tested positive to rabies both by rapid test and FAT.

5.3. Zoo sanitary measures

- The team worn the protective gear (lab coat, face mask, hand gloves (double layer) prior to handling the carcasses.
- The rabies virus is fragile and cannot survive in the environment for a long time. The virus can be killed exposure to sunlight and also by water and soap solution. However, in order to protect the team and avoid possible exposure, a detergent solution was prepared and sprayed on and around the carcasses prior to handling and brain sample collection.
- The carcasses were buried at the site of death including the bedding and contaminated materials.
5.4. Mass dog vaccination program

- Eight temporary vaccination points were created to conduct mass vaccination program. The owners were informed to bring their dogs and cats to the vaccination points. Stray dogs were also captured and vaccinated. A capture-mark-resight method was applied at the time of mass dog vaccination program. The identification mark through spraying of vegetable colour paints was applied on the body of the vaccinated dogs before being released into the place of capture or released by owners in case of owned dog. This is to identify vaccinated dog, avoid repeated capture, and also to assess the coverage. The dogs along the national highway were also captured and vaccinated against rabies.

- A total of 382 dogs and cats (dogs: 211; cats: 171) were vaccinated against rabies by RRT. Of the 211 dogs, 69 (33%) were stray dogs captured by the team for vaccination.
5.5. Risk communication

- Conducted public awareness education on rabies and public health risk of dog bites. The public were also advised to wash any animal bite wound with soap and water for at least 15 minutes and report to the health centre for advise instead of performing local treatment of bite wound.
- The dog owners were also advised to keep their dogs within the compound for at least 1-2 months till the rabies outbreak has subsided.
- The public were also made aware to take their dogs to the livestock extension centre for registration and vaccinate against rabies annually to protect them against rabies.
6. Main findings of investigation and discussion

1. A total of one suspected and two confirmed rabies cases in cattle (JX calves below 7 months of age) and one confirmed case of rabies in stray dog was identified in Orong village while two stray dog in Naphung, one stray and one pet dog in Samdrup Jongkhar town were confirmed to have died rabies. Approximately 10 stray dogs have also died of suspected rabies in OHSS area. However, the pet dog which has bitten two calves have disappeared from the owner house and could not be traced. The dog might have died on 18/12/2015 given the short clinical course (~3 days) of the disease and high fatality rate (100%).

2. A total of 82 people have reported to Orong BHU between November 1, 2015 and January 21, 2016 for rabies PEP. Of these only four people have been bitten by a confirmed rabid dog whilst 33 were bitten by a suspected rabid or apparently healthy dogs or cats. The remaining 45 people had exposure related to consumption of dairy products and milk from three cows whose calves were confirmed rabid (but cows were not rabid)(see point no 12 below for detail discussion).

   A total of 29 people have reported to Deothang hospital during December 2015 and January 21, 2016 related to consumption of dairy products and milk from same cows at Orong.

   All people were treated (given PEP) in both Orong BHU and Deothang hospital as per the National Guidelines for Management of Rabies 2014, although the risk of rabies transmission through consumption of milk is negligible.

3. Movement of rabies infected stray dogs from the border town (Darrang-Samdrup Jongkhar border town) to Deothang and Orong was the most likely source of the current rabies outbreak in Orong/Naphung. This is based on the following observation and justification:

   i. The team noted (observed) the movement of stray dogs daily along the S/Jongkhar-Deothang-Naphung national highway in both direction (see picture below);

   ii. The stray dogs were also found in labour camps and the hotel/restaurant along the national highway;

   iii. Interview with people at Lerong village (village located between Orong and Shekpashing (a takeoff point from national highway to Orong) revealed that the stray dogs from Shekpashing or national highway move to Orong;

   iv. Interview with the people (e.g. labour camps) also indicated movement of stray dogs along the national highway;

   v. Rabid stray dog was captured live at Charkilo (4 kms from S/Jongkhar towards Deothang) on 27/1/2016 and the dog supposedly moved from S/Jongkhar-Darrang towns (see picture below) and the brain tissue from this dog was tested positive to rabies, thus confirming that rabid dogs move from border town to north following the national highway (see recommendations).
4. Translocation of stray dogs (possibly rabies virus infected dog but under incubation period) from the border towns and subsequently released along the Deothang-Narphung highway and movement to Orong is the second most likely source of rabies in Orong and Narphung.
   i. Interview with the shop/restaurant/hotel owners in Narphung and Shekpashing and residents of labour camp along the national highway indicated that they have seen stray dogs released along the national highway and Narphung area increasing the dog population. These dogs eventually do move into the villages (see recommendations).

5. Movement of pet dogs (may be under incubation period) from S/Jongkhar border towns or Deothang and contact with local dogs in Orong is also a possible source and mode of rabies transmission. Although this scenario could not be confirmed during investigation, it is likely to happen and moreover, the owner would not reveal the truth fearing repercussion.
   i. For instance, in case of Case no 8 described above, a pet dog was taken from Deothang to Samdrup Jongkhar on 23/01/2016 and the dog showed symptoms of rabies on 2/2/2016 and died on 4/2/2016. The brain tissue was tested positive to rabies. This indicate that there could have been silent circulation of rabies among dogs in Deothang and movement of pet could play a role in initiating rabies outbreak.

6. Investigation and interview with the public confirm that there was no involvement of wildlife in the transmission of rabies. No wild life attack on animals have been noted in Orong. Moreover, approximately 99% of rabies cases in developing countries are related to dog mediated rabies and wildlife play a minimal role in rabies transmission. Nevertheless, testing of brain tissue from wild animals (wild canine/feline species) if found dead would confirm the hypothesis.

7. Examination of the dog bite and PEP cases registered at Orong BHU indicated that there was increased report of dog and cat bite in humans during November and December 2015 when compared to other months, providing some evidence that mass dog bite (may be due to rabies)
have occurred during November and December 2015. A total of 15 number of dog bites cases have been reported in OHSS and OLSS campus alone during November & December 2015. The unusual pattern of increased number of dog bite cases reported to the hospitals can be used as sentinel surveillance for possible rabies outbreak and the information should be shared with veterinary authorities and relevant authorities for investigation (see recommendations).

Fig 25: Dog & cat bite cases in human reported for PEP at Orong BHU between Jul 2015 & Jan 2016

8. Similarly, examination of animal bite (dog & cat) cases in human reported to Deothang hospital for treatment also indicated increased number of cases during 2015 when compared to 2014 with more cases reported between May and December 2015. These suggest that there could have been occurrence of undetected rabies cases in stray dogs. The unusual dog bite pattern in human can be used as a sentinel surveillance or indirect way of understanding any circulation of rabies in stray dog (see point No 7 above and recommendations).

Fig 26: Dog & cat bite cases in human reported for PEP at Deothang hospital during 2014 & 2015
9. Approximate incubation period (IP) and clinical course of rabies in animals (dogs & calf) have been noted in the field condition as follows. This information can be validated with other research findings or from other field case findings in the country. However, IP would depend on the site of bite, severity of the bite wound and amount of virus inoculated at the site of bite. The understanding the IP of the disease is relevant for disease prevention and control such as: determination of the length of quarantine/isolation required for a potentially exposed individual (i.e., by restricting movement of an exposed individual for a duration sufficiently longer than the incubation period); estimation of the transmission potential and infectiousness (for modeling); and to determine the causes and/or sources of infection.

Table 1: Details of exposure, incubation period and clinical course of rabies in dogs and cattle

<table>
<thead>
<tr>
<th>Animal ID</th>
<th>Date of bite (exposure)</th>
<th>Onset of clinical symptoms</th>
<th>Incubation period (days)</th>
<th>Date of death</th>
<th>Duration of clinical course</th>
<th>Site of bite</th>
<th>Test result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case 2 (JX, female, 7 month)</td>
<td>12/12/2015</td>
<td>28/12/2015</td>
<td>16 days</td>
<td>11/01/2016</td>
<td>15 days</td>
<td>nostril</td>
<td>not tested</td>
</tr>
<tr>
<td>Case 3 (JX, male, 6 month)</td>
<td>15/12/2015</td>
<td>08/01/2016</td>
<td>24 days</td>
<td>11/01/2016</td>
<td>4 days</td>
<td>ear</td>
<td>rabies positive</td>
</tr>
<tr>
<td>Case 4 (JX, male, 6 month)</td>
<td>16/12/2015</td>
<td>17/01/2016</td>
<td>32 days</td>
<td>22/01/2016</td>
<td>6 days</td>
<td>nostril</td>
<td>rabies positive</td>
</tr>
<tr>
<td>Case 6 (stray dog, male, adult)</td>
<td>Unknown (approx. 6/1/2016)</td>
<td>27/01/2016</td>
<td>Unknown (approx. 21 days)</td>
<td>31/01/2016</td>
<td>4 days</td>
<td>unknown</td>
<td>rabies positive</td>
</tr>
<tr>
<td>Case 8 (pet dog, male, 3 years)</td>
<td>Unknown (approx. 12/01/2016)</td>
<td>02/02/2016</td>
<td>Unknown (approx. 21 days)</td>
<td>04/02/2016</td>
<td>3 days</td>
<td>unknown</td>
<td>rabies positive</td>
</tr>
</tbody>
</table>

10. There are large number of owned dogs and cats in Orong, but majority were found to be free-roaming in the villages. This was confirmed during the conduct of mass dog vaccination in the villages (owned dogs). Those dogs vaccinated were given temporary marks by painting vegetable colour dye on their body. Most marked dogs were found roaming the villages in subsequent days (see recommendations).

11. Discussion with the health officials in both Orong BHU and Deothang hospital have indicated that all reported animal bite cases in human are given rabies PEP as per the National Guidelines for Management of Rabies 2014. The intradermal PEP procedure has been adopted and are running successfully both at BHU and Hospital level (see the human PEP cost estimate below).
12. Three calves (below 7 months of age) have been bitten by a suspected rabid dog and have died after showing clinical signs of rabies and also confirmed rabid by laboratory test whilst the dam (cow/mother) of these calves were apparently healthy and have been milking. There was confusion that these calves while sucking the teat might have transmitted the virus to the dam/mother through injury to the teat. As a result, all people (n=47) who have consumed milk and dairy products from these cows have reported to the health centres and were given rabies PEP. The milk from these cows were milked and discarded for about one month.

The incubation period of rabies (time period between date of exposure/bite and onset of clinical symptoms) in these 3 calves were in the range of 16 to 32 days (see findings - point no 9 above). The calves were isolated and not allowed to suckle the milk after the onset of clinical symptoms which could have prevented injury to the teat. There is also a possibility that the rabies virus might have been transmitted through teat canal. However, there was 48, 37, 28 days time elapsed in case of Case No 2, 3, and 4, respectively between the of onset clinical symptoms in three calves and the survival of the dam as of 14/02/2016. Currently, the cows are apparently healthy and were advised to isolate and monitor the health status regularly. The incubation period of rabies in cattle is variable and ranged from 15 days to 15 weeks. However, two cows (Case No 3 and 4) are under post exposure rabies prophylaxis treatment (see point No. 9 above for incubation period in calves and also recommendations point No 1 below).

13. We have observed that there was no wide spread rabies transmission in dog population although there were more than 200 dogs in Orong and Narphung area, mostly free-roaming. This may be because of very low basic reproductive ratio (R₀ =1.2) of rabies when compared to other infectious diseases [due to short incubation period (~21 days), short infectiousness of rabies (3.1 days), short clinical course (~3 days) and high case fatality rate (100%) of rabies in dogs]. Moreover, the biting behavior of rabid dog during the course of infectious period is variable with a mean bites per rabid dogs of 2.15 only [meaning a rabid dog may bite only 2 other dogs during 3 days of infectious period]. Again, all bites may not necessarily result in transmission of virus to other dogs because of
many factors [bite wound is not severe; virus not inoculated into the bite wound, animal may have been vaccinated against rabies prior to bite or after bite, etc.], and only about 50% of the bite by rabid dog to other dogs is expected to succumb to disease.

The basic reproductive ratio $R_0$ is the average number of secondary cases produced from a single primary case over the course of its infectious period, in an otherwise uninfected and fully susceptible population. This threshold parameter is useful because it helps to determine/predicts whether or not an infectious disease can spread through a population. When $R_0 < 1$, the infection will die out in the long run and if the $R_0 > 1$, the infection will be able to spread in a population. When the $R_0$ is large, it will be harder to control the outbreak, but it would depend on several other factors such as duration of infectivity, the number of susceptible population that the affected individuals are in contact. What does $R_0$ of rabies = 1.2 mean? This means one rabid dog would on an average result in 1.2 secondary cases (one more rabid dog) during the course of infectious period (3.1 days) in a fully susceptible population (dog population that has not been vaccinated against rabies).

The proportion of the dog population that needs to be vaccinated to prevent sustained spread of rabies is given by $1 - (1/ R_0)$. For instance, if the $R_0$ is 1.2, then the critical vaccination threshold for rabies elimination is only about 17% (meaning 17% of the dog population may needs to be vaccinated to eliminate rabies), but there is considerable variation in the field condition wherein rabies have been successfully controlled with low level of vaccination coverage in some circumstances whilst higher level of coverage have also failed to control rabies. This can be explained by the demography of the dog population in the area wherein the herd immunity declines rapidly in the interval between vaccination campaigns because of births and deaths in dog population (the vaccinated dogs may die (old age, diseases, accidents, kill etc..) and will be replaced by birth of unvaccinated dogs in the population). Thus the dog population turnover appears to have had a marked influence on rabies dynamics. Therefore, in order to maintain the herd immunity above the critical threshold, at least 70% of the dog population should be vaccinated against rabies during annual vaccination campaigns.

7. Financial impacts of disease, investigation & response

The total estimated cost of rabies outbreak in Orong, Narphung and Samdrup Jongkhar town between November 2015 and January 2016 was estimated to be Nu. 2,59,703. Of the total estimated cost, Nu. 1,64,872 was borne by the government as direct cost and Nu. 94,831 as indirect cost (income loss for the people, cost borne by people) with a total societal cost (direct + indirect cost) of Nu. 2,59,703.

The detail cost description includes the following:

<table>
<thead>
<tr>
<th>PART A: DIRECT COST</th>
</tr>
</thead>
<tbody>
<tr>
<td>DSA &amp; TA cost for the investigation (8 team visit for 8 times)</td>
</tr>
<tr>
<td>Investigation &amp; sample collection cost (6 times visit)</td>
</tr>
<tr>
<td>Investigation &amp; awareness program cost (1 time visit)</td>
</tr>
<tr>
<td>Investigation &amp; rapid response cost (1 time visit)</td>
</tr>
<tr>
<td><strong>Sub-total</strong></td>
</tr>
<tr>
<td>Cost (Nu.)</td>
</tr>
</tbody>
</table>
Investigation and Control of Rabies Outbreak in Samdrup Jongkhar

Mass dog vaccination cost  
Rabies vaccine cost (382 doses)  
Syringe & needle cost  
Hand gloves cost  
Face mask cost  
Vegetable colour paint cost  
Sub-total  

Cost (Nu.)  
8022  
1200  
400  
72  
360  
10,054  

Human PEP cost  
Intradermal rabies vaccine cost for 111 people (S/Jongkhar hospital not included)  
Administration (overhead) cost (nurse time cost)  
Wound dressing (materials & overhead) cost for 37 dog bite cases  
Sub-total  

Cost (Nu.)  
46153  
9784  
999  
56,936  

Laboratory test cost of brain tissue  
Anigen rapid rabies Antigen test kit cost  
Sub-total  

Cost (Nu.)  
1608  
1,608  

Total Direct cost (cost borne by the government)  

Cost (Nu.)  
1,64,872  

PART B: INDIRECT COST (cost borne by people)  

1. Animal & income loss cost  
Death of 3 JX calves (one female and two male calves)  
Income loss due to discard of milk (after confirming rabies in calves)  
Sub-total  

Cost (Nu.)  
16000  
18900  
34,900  

2. Income loss for farmers  
Income loss to bring pet dogs for mass dog vaccination & attend meeting (175 owners) based on the minimum wage of Nu.215/day (Nu.26.88/hour)  
Income loss while attending investigation & awareness meeting  
Income loss for 64 adults to visit 4 times to BHU for rabies PEP  
Income loss for 23 parents to visit 4 times to BHU for rabies PEP for accompanying children to complete PEP (children have no income)  
Sub-total  

Cost (Nu.)  
9406  
12900  
27520  
10105  
59,931  

Total indirect cost (income loss cost, cost borne by public)  

Cost (Nu.)  
94,831  

PART C: SOCIETAL COST  

Societal cost  
Direct cost  
Indirect cost  
Total cost of rabies outbreak & containment  

Cost (Nu.)  
164872  
94831  
2,59,703
Cost comparison between IDRV and Intramuscular PEP regimen

If the intramuscular Essen regimen has been used to provide PEP in human, the direct cost for the government was estimated to be Nu. 1,79,265 and Nu. 47,031 as indirect cost which would have been borne by the people (income loss). The estimated societal cost (direct + indirect cost) would have been Nu. 2,26,296. There was a cost saving of Nu.1,22,328 (68% cost reduction) for the government after the introduction of IDRV in the country.

8. Recommendations

1. The health status of three dam (cow) of three confirmed rabid calves should be monitored regularly for onset of any clinical signs of rabies and report for investigation.
   **Action:** RNR-EC (Livestock), Orong

2. After the closure of two schools in Orong, the stray dogs in the school campus have moved into the villages and most of those dogs could not be captured for vaccination during recent RRT operation. These dogs would return when the school reopen in February 2016. It is recommended that all these dogs should be captured and vaccinated against rabies when the school reopen in February on priority.
   **Action:** RNR-EC (Livestock), Orong, DVH S/J, Orong HSS & Orong LSS

3. The students and teachers of both the schools (OHSS & OLSS) be made aware of the recent rabies outbreak in Orong and adjoining areas and cautioned to avoid handling dogs to prevent dog bites. They should also be educated on wound washing (if in case of any dog/animals bites) and importance of reporting to health centres for advice.
   **Action:** RNR-EC (Livestock) and BHU, Orong

4. Since there is serious risk of rabies incursion from the border towns, it is important that mass dog vaccination (both stray and pet) be conducted immediately in Samdrup Jongkhar-Darrang border towns and Deothang with more than 70% coverage. This is to create immune buffer and prevent spread of rabies into interior eastern Bhutan. The vaccination campaign should be conducted annually.
   **Action:** NDPM & RCP, NCAH and Dzongkhag Livestock Sector, S/Jongkhar

5. In order to further confirm the movement of stray dogs as responsible for rabies outbreaks in Orong, Narphung and also frequent outbreak in Deothang, dog movement study be conducted in S/Jongkhar and Deothang and along the National highway between Narphung and S/Jongkhar town at the time of mass vaccination campaign. The information generated from this study will enhance the disease surveillance and preparedness plan in future.
   **Action:** DPCU, NCAH; RLDC, Khangma; SVL Deothang & DVH S/Jongkhar

6. A molecular characterization & phylogenetic analysis of rabies virus be conducted to understand the source and pattern of rabies outbreak in Orong and adjoining areas.
   **Action:** DPCU and LSU, NCAH
7. Any dog bite cases in humans at Narphung, Orong, Deothang, Samdrup Jongkhar and nearby areas (e.g. along the S/Jongkhar-Narphung highway) should be given rabies PEP irrespective of the status of the dogs (whether rabid dog bite or bite by apparently healthy dog) because of the recent outbreak events and also due to sporadic occurrence of rabies in Samdrup Jongkhar-Deothang areas (treatment to be given as per the National Guideline for Rabies Management 2014).

**Action:** BHU, Orong; Dzongkhag Hopsital, S/Jongkhar and Deothang hospital

8. All owned dogs and cats should be registered with Livestock Extension centre and the owner should be educated for responsible dog ownership. The dogs and cats should be vaccinated against rabies annually. The awareness education should be created among the public during any of the geog public gathering convened by the geog authority. This is as per the Livestock Rules and Regulation of Bhutan 2008.

**Action:** RNR-EC (Livestock) Orong, Gomdar & Deothang in coordination with Geog Authority

9. It is likely that sporadic rabies outbreaks in stray dogs may be occurring in S/Jongkhar border towns, Deothang and along the S/Jongkhar-Narphung national highway. The cases may have gone undetected due to short clinical course of rabies (~3 days), high case fatality rate (100%), nature of the disease (e.g. occurrence of dumb form of rabies), and lack of public awareness on importance of reporting any sick stray dogs. Therefore, it is important to enhance surveillance to detect case(s)/outbreaks in dogs by making regular visits to the high risk areas/towns and find out any unusual pattern of dogs deaths through direct observation and public enquiry, informal appointment of key informants (e.g. tsokpa) in strategic areas and making phone call, testing of any dog carcasses brain tissue samples for rabies (e.g. carcasses seen on highway/road (dogs killed by vehicle), by detection of increased number of cases of dog bites in humans reported to the hospitals for treatment (sentinel surveillance) & sharing of information with the veterinary authorities for investigation.

**Action:** SVL, Deothang; DVH S/Jongkhar, Human hospitals (Deothang & Samdrup Jongkhar); RLDC-Khangma

10. Any cases of animal deaths (e.g. stray dogs/cats/cattle) should be examined for presence/absence of rabies. Even if rabies has been confirmed in an area and declared the area as confirmed rabies outbreak zone, the brain tissue sample from all the carcasses should be collected and tested for rabies.

**Action:** SVL Deothang & DVH Samdrup Jongkhar

11. Since rabies cases in stray dogs in Narphung town has been confirmed, there is a possible risk of spread into Gomdar geog (villages adjoining Narphung and also Gomdar geog centre area). Therefore, it is important to strengthen the surveillance system and take appropriate measures. The dog bite cases reported to Tshangchilo (Gomdar) BHU should also be monitored and share information with Livestock officials for investigation.

**Action:** RNR-EC (Livestock) Gomdar geog, BHU Gomdar, Dzongkhag Livestock Sector, S/Jongkhar, Dzongkhag Health Sector, S/Jongkhar
12. The Community Animal Birth Control program (CABC) should be conducted to manage the dog population and reduce rabies incidences. In addition, the success of Thimphu Thromde initiatives on dog population management should be replicated in S/Jongkhar Thromde.

**Action:** DVH S/Jongkhar, RLDC Khangma, NDPM & RCP, NCAH

### 9. Acknowledgements

I would like to thank Mr. Yeshey Wangpo and his family (RNR-EC, Orong) for providing logistic support to the RRT during field investigation in Orong. The management of NCAH and Dzongkhag Livestock sector, Samdrup Jongkhar are also acknowledged for their support and guidance. All RRT members are also acknowledged for their hard work during investigation and mass vaccination program.

**Appendix**

**Table 1: Total number of dogs and cats vaccinated against rabies by RRT**

<table>
<thead>
<tr>
<th>Place name</th>
<th>Cat</th>
<th>Dog</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arong</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Belam</td>
<td>11</td>
<td>4</td>
<td>15</td>
</tr>
<tr>
<td>Brekha</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Chongti</td>
<td>12</td>
<td>7</td>
<td>19</td>
</tr>
<tr>
<td>Dengzor</td>
<td>1</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Dengzor Onestop shop</td>
<td>0</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Durtshun</td>
<td>9</td>
<td>5</td>
<td>14</td>
</tr>
<tr>
<td>Fatpar</td>
<td>3</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Gonmenang</td>
<td>1</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Gonpa</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>HSS area</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Jalam</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Jalamwong</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Jangchubling</td>
<td>12</td>
<td>7</td>
<td>19</td>
</tr>
<tr>
<td>Kharowa</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>OLSS</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Malang</td>
<td>4</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Mandhar</td>
<td>11</td>
<td>2</td>
<td>13</td>
</tr>
<tr>
<td>Mantshang</td>
<td>20</td>
<td>13</td>
<td>33</td>
</tr>
<tr>
<td>Melum</td>
<td>12</td>
<td>9</td>
<td>21</td>
</tr>
<tr>
<td>Menchari</td>
<td>8</td>
<td>16</td>
<td>24</td>
</tr>
<tr>
<td>Metshishing</td>
<td>4</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td><strong>Total dogs</strong></td>
<td></td>
<td></td>
<td><strong>211</strong></td>
</tr>
<tr>
<td><strong>Total cats</strong></td>
<td></td>
<td></td>
<td><strong>171</strong></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>382</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Place name</th>
<th>Cat</th>
<th>Dog</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Miktangkhar</td>
<td>0</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Morong</td>
<td>17</td>
<td>12</td>
<td>29</td>
</tr>
<tr>
<td>Nala</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Narphung</td>
<td>0</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Orong</td>
<td>2</td>
<td>32</td>
<td>34</td>
</tr>
<tr>
<td>Pheldung</td>
<td>3</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Rengakpa</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Ridumey</td>
<td>4</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Shekpashing</td>
<td>0</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>Shekpashing-GREEF</td>
<td>0</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Suzung</td>
<td>10</td>
<td>17</td>
<td>27</td>
</tr>
<tr>
<td>Tapkangyey-GREEF</td>
<td>0</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Tertsheri</td>
<td>2</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>Therphu</td>
<td>3</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Thongkorong</td>
<td>3</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Thongsra</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Tokorong</td>
<td>0</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Tokorong GREF camp</td>
<td>0</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Wooling</td>
<td>9</td>
<td>2</td>
<td>11</td>
</tr>
<tr>
<td>Wulkar</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Yangkhar</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>