Recent Developments in Rabies Epidemiology & Sources of Information in India

16th January, 2015
Gurgaon
Recent Developments in Rabies Epidemiology & Sources of Information in India

16th January, 2015
Gurgaon
Purpose & Organisation of this Report
This report synthesises the discussions created around rabies epidemiology in India and the impacts that different programmes may have on rabies in India. It is an outcome of the meeting on “Recent Developments in Rabies Epidemiology & Sources of Information in India” held in Gurgaon on 16th January, 2015 organised by the Public Health Foundation of India/Roadmap to Combat Zoonoses in India (RCZI) Initiative.¹ The meeting was supported by the Bill & Melinda Gates Foundation under the Grand Challenges Exploration Award.

It presents existing rabies challenges, information sources and interventions within the Canine, Wildlife, Livestock and Humans domains. Experts from each of these fields discussed issues around transmission, management of rabies and costs and benefits of rabies control in India before presenting their insights into why India still contributes a large burden globally. These discussions were conducted as parallel breakaway sessions in small groups which deliberated amongst themselves before presenting their thoughts to the larger group. The synthesis of their discussions is presented here alongside some of the recommendations that focused on strengthening the research agendas for public health, veterinary public health, wildlife health, conservation and environmental or ecological health. The report brought out the criticality of joint-sectoral coordination and the consensus of the group on taking the discussions forward in the months to come.

¹ The RCZI was launched in March 2009, modelling itself around the ‘One Health’ concept with the primary goal to create a neutral, research and advocacy-centric, convening platform that mobilises partners working across human, wildlife and veterinary sectors.
## Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Executive Summary</td>
<td>5</td>
</tr>
<tr>
<td>Background</td>
<td>7</td>
</tr>
<tr>
<td>Canine Sector</td>
<td>13</td>
</tr>
<tr>
<td>Wildlife Sector</td>
<td>15</td>
</tr>
<tr>
<td>Livestock Sector</td>
<td>19</td>
</tr>
<tr>
<td>Human Sector</td>
<td>22</td>
</tr>
<tr>
<td>Key Outcomes Used to Measure Effectiveness</td>
<td>24</td>
</tr>
<tr>
<td>Recommendations</td>
<td>25</td>
</tr>
<tr>
<td>Conclusion &amp; Next Steps</td>
<td>27</td>
</tr>
<tr>
<td>References</td>
<td>28</td>
</tr>
<tr>
<td>Annexures</td>
<td>30</td>
</tr>
<tr>
<td>• Agenda</td>
<td>31</td>
</tr>
<tr>
<td>• List of Participants</td>
<td>32</td>
</tr>
<tr>
<td>• Parallel Session 1 ToRs: Transmission Dynamics of Rabies</td>
<td>33</td>
</tr>
<tr>
<td>• Parallel Session 2 ToRs: Management of Rabies in India</td>
<td>35</td>
</tr>
<tr>
<td>• Parallel Session 3 ToRs: Costs &amp; Benefits of Rabies Control</td>
<td>37</td>
</tr>
</tbody>
</table>
South Asian countries contribute to more than half the global burden of rabies. However, in spite of the longstanding nature of the problem and despite presence of effective intervention strategies for rabies control, rabies continues to pose a major public health challenge to programme managers and policy makers in the region and elsewhere. Most South Asian countries are yet to develop sustainable, population-level rabies control strategies, such as routine availability of post exposure prophylaxis (PEP) in humans, dog immunization and dog population control.

Need for a sound economic evaluation on rabies control

Within the context of India, with the exception of a costs analysis study conducted by the Public Health Foundation of India (PHFI), no economic evaluation has been conducted on rabies control. Lack of availability of valid and quality data to inform studies which research cost-effectiveness of infectious disease has further deepened the knowledge gaps.

Earlier research showed that while estimating efficiency and impact of an intervention, costs were mostly taken into account from multiple sectors but benefits were portrayed from only one sector. Resultantly, in case of rabies, there has been growing consensus on the need to optimise investments and maximise benefits across sectors.

Over the last few years, the Roadmap to Combat Zoonoses Initiative (RCZI), through its work in India through its strategic research agenda, the Tamil Nadu case study and a costing study on rabies intervention generated meaningful rabies-related dialogue, taking a more holistic and evolved view. A key outcome of these discussions has been growing agreement amongst stakeholders on the huge mismatch in the kind of funds required for delivering interventions from the animal and human sides. To overcome this challenge, a decision analytical tool has been proposed to bring together information from all sectors and to ensure that an effective collaboration is facilitated.

In order to facilitate joint decision making through visualisation of costs and benefits of rabies control interventions to multiple sectors simultaneously, PHFI/RCZI proposed the development of novel methods for epidemiologic and economic evaluation. This will allow cumulative impact assessment of interventions across the livestock, canine, wildlife and human sectors.

Expert interaction allows for greater insights and commitment to rabies related research

As a preliminary step to finalising a framework, there has been a need to establish better understanding of recent advances in rabies control in India. Therefore, PHFI/RCZI organised a brainstorming meeting in New Delhi in November, 2014.

The theme of “Recent developments in rabies epidemiology and sources of information to assess impact of rabies and its interventions in India” aimed to encourage sharing and discussion on recent developments in rabies while identifying potential resources/information sources, providing clarity on transmission routes and most importantly, outlining working relationships between sectors.

The day-long meeting saw active brainstorming on the One Health Approach, with views on how the disease originates in some sectors and crosses species barriers. Discussion ensued on how application of interventions in one sector could lead to benefits in other sectors. Their chief concern was that despite importance of
Recent Developments in Rabies

multi-sectorality, it has been difficult to engage in a multi-sector dialogue. This was attributed to the different agendas of sectors, with human health sector trying to maximise quality of life while veterinary health sector focused on productivity. The experts also touched upon some of the reasons why rabies is a disease that has not been treated as a priority, leading to a scenario where there have been much fewer investments from policy makers as compared to other diseases.

There was consensus on a number of issues, such as urgent need to overcome the challenge of having minimal research in the field of transmission dynamics of rabies in different species in India. Also, it was emphasised that the livestock and wildlife sectors must review their research agendas and identify new areas of research that can provide valuable inputs on control and prevention efforts. Suggested themes for research related to epidemiology and transmission dynamics of rabies in animals and humans; dog ecology and dog demography studies; efficacy, effectiveness studies, within and across sectors of rabies interventions; wildlife studies on rabies transmission; socio-cultural and behavioural studies on rabies; health economic studies regarding the cost-effectiveness of interventions and economic analysis of health policy for rabies.

The Consultation concluded with the recommendation that a more balanced approach was needed, especially in according the animal sector as much importance as the human sector. This should be not just in terms of funding opportunities but also involvement and engagement in prevention and control efforts. The expert view was that the approach, so far, had been to analyse costs involved from multiple sectors while viewing benefits gained from one sector. In the case of rabies however, it would be critical to map all existing costs and benefits of interventions to help inform evidence-based decision making.
Zoonosis & Rabies in India

Figure 1: How rabies transgresses the human-animal-wildlife interface and their respective priorities

Zoonosis are diseases that are naturally transmitted between animals and humans. Ever since humans have come in contact with animals, there have been zoonotic diseases. Domestication of animals has contributed to creating perfect conditions for zoonotic pathogens to be transmitted to humans. Approximately 75% of recently emerging infectious diseases affecting humans are diseases of animal origin and approximately 60% of all human pathogens are zoonotic.

In recent times, urbanisation and expansion of human habitats and invasion of wildlife areas have resulted in intensification of the human-animal interface. Human behaviours (hunting for bush meat in rural settings) and preference for keeping wild animals as exotic pets has brought humans closer to animals and their pathogens. Increased and easy movement of populations through air travel has compounded the spread of these infections. Zoonosis and the likelihood of their spread to humans exist in a variety of ecosystems, namely, urban, rural, occupational, wild areas, domestic and pet settings.

Not surprisingly, nearly 800 of the 1400 known human pathogens are of zoonotic origin and over 75% of newly emerged infections in the last three decades are zoonosis. Besides being a public health problem, many of them prevent the efficient production of food of animal origin, obstructing international trade in animal products, impacting livelihoods, amongst other things.

Quick facts on rabies in India

- India produces highest number of rabies cases in the world with approximately 20,000 human deaths a year or 50% of global burden of rabies
- 76% of all rabies cases in India are reported from rural populations
Recent Developments in Rabies

Rabies, a neglected zoonotic disease in India

Rabies is a zoonotic viral disease that causes acute inflammation of the brain in humans and other warm blooded animals, namely canines, livestock and wildlife. Domestic dogs are the main vector, with the disease being transmitted mostly through close contact of infected material such as saliva and usually through bites and/or scratches. Every year, globally, more than 55,000 deaths are attributed to rabies, with 95% taking place in Asia or Africa. With nearly two thirds of India’s population living in rural villages, their vulnerability to zoonotic infections and disease is high, more so, since more than half of the reported cases are recorded in rural settings.

Not enough attention being given to rabies at the policy level

The landscape of rabies control is complex, with departments of animal welfare, public health, veterinary medicine and civil administration harbouring different perspectives and expectations of what a rabies control programme should be. In such a scenario, simple intervention strategies are unlikely to meet needs of disease prevention and control. In the absence of well nuanced epidemiological studies, a comprehensive understanding of rabies control remains elusive, limiting the design and implementation of effective, acceptable and sustainable policy solutions.

A key reason why not enough attention is being paid to rabies control and prevention is the “research to policy disconnect”. Although efforts have been made, with repeated disease prioritisation exercises, the 12th Five Year Plan and several other state-level interventions, the drive has to be intensified with vaccination for high-risk individuals, surveillance of human cases, post-exposure prophylaxis (PEP) following animal bites, vaccination and/or culling of canine population and other animal reservoirs, amongst others.

Research to Policy Disconnect

Many countries in Europe and North America have successfully eliminated and/or controlled rabies, using proven intervention strategies, such as PEP in humans and animal birth control and immunization among dogs.

India, however is yet to show similar results. Despite substantial global research funding for neglected diseases, India’s contribution remains relatively negligible in relation to global research output. Further, limited research output that exists in the health sector is not completely aligned to public policy needs. Clearly, there is a research to policy disconnect that prevents translation of scientific research outputs into effective policies in rabies and other health domains.

Rabies research conducted in India has potential to influence the rabies agenda nationally as well as in many low-and middle-income countries (LMIC) if more policy relevant research is conducted. RCZI’s own studies on rabies highlight the importance of moving beyond a purely researcher-driven agenda, suggesting the need to promote research that has a vision for rabies control in the near future.

Rabies research globally has generated actionable evidence on rabies control. Yet rabies control efforts continue to be neglected in many LMICs. There is disconnect between information needs of public health planners and evidence generated by the research community. This research-policy gap can be addressed through a specially developed strategic research agenda for rabies control at national and regional levels.

RCZI’s Commitment in Understanding Rabies

Efforts to create a national rabies control programme in many LMICs, including India, have not been successful because of challenges in conceptualising a programmatic structure for a multi-sectoral effort. Inadequate interaction and communication within the policy-making communities and between research, programme and policy actors is caused and exacerbated by lack of collaborative platforms, differences in perspectives and institutional barriers.
The RCZI network aims to bridge some of these challenges through its research, capacity building and advocacy efforts.

**Developing a research agenda for rabies control**

While rabies research in India might not be completely reflective of global priorities, RCZI has used it as an illustrative case study to highlight points that can be used to inform a larger discussion on prioritisation for rabies research globally. By proposing development of a strategic research agenda at national and regional levels, RCZI has looked at rabies control among affected populations as an expected outcome, with a view to help planners evolve a unified vision of rabies control involving a closer interaction of different disciplines (epidemiology, economics, life sciences and sociology, among others), sectors (human, animal and environment) as well as functions (researchers, practitioners, policy planners, donor representatives).

RCZI’s belief is that the policy relevance of conducted research can only increase when close relationships between policy, programme and research are strengthened.

**Learnings from Tamil Nadu’s rabies control efforts**

Tamil Nadu has been the first state in India to offer a population-wide rabies control programme and implement a state-wide, multi-sectoral rabies control initiative. Guided by the CDC Programme Evaluation Framework, RCZI conducted an assessment in 2010 to review rabies prevention and control initiatives while focusing on mechanisms that helped Tamil Nadu achieve inter-sectoral coordination.

The study found comprehensive human and animal-side interventions being implemented through a joint inter-sectoral coordination mechanism involving state departments that were responsible for public health, municipal administration, town administration, village panchayats and veterinary public health. While the state government viewed this mechanism as an administrative instrument, the assessment appreciated other benefits of having a One Health coordination mechanism in place.

The Tamil Nadu case study showed the possibility of implementing a successful One Health programme in an environment of strong political will backed by evidence-based policy innovations, clearly defined roles and responsibilities of agencies, strong coordination mechanisms at all levels and a culture of open information exchange.

**Developing a cost-analysis framework for rabies control**

The Tamil Nadu study had a number of firsts to its credit. It was for the first time anywhere that a rabies control intervention covering such a large population was costed and for the first time in South Asia, that simultaneously implemented interventions on animal and human side were costed. Although the study only looked at cost of the intervention and not benefits accrued or other indirect costs associated with the disease, it helped develop a framework for estimating costs of the rabies control initiative in Tamil Nadu, providing an estimate of the cost of implementing different interventions for controlling rabies among entire human and animal populations in the state.

The cost analysis of rabies control programmes in the country showed that the choice of vaccination route contributed least to government cost savings compared to other drivers of programme costs (procurement, wastage rates of different vaccine formulations, incidence of dog bites). Thus, cost-savings from a centralised procurement and supply chain management system were likely to be outweighed by costs of uniform adoption of intradermal vaccination. Also, the intradermal use policy did not always lead to vaccine savings but could on the contrary, increase transaction costs of vaccination due to increased needs for training and supervision of vaccinators.
Additionally, while canine vaccination was a suggested strategy of choice towards elimination of rabies, there was not enough documentation to indicate expectations of local communities or rabies control programme managers, with respect to how the strategy would work. Modelling of pilot canine vaccination interventions in India too showed that a coverage of 70% would have to be sustained over two decades before the intervention could be found effective. Besides, unless accompanied with dog population control, the strategy would unlikely reduce number of dog bites or costs of PEP.

The study clearly brought out the need for researchers and policy-makers to jointly promote evidence-based policy-making in their effort to implement rabies control efforts in the country. A first step for this would be to undertake systematic economic evaluations with respect to rabies.

The Role of Economic Evaluations in India

In the domain of health and healthcare, economic evaluations help assess the efficiency of interventions which can help policy makers and programme managers to make informed decisions. Where zoonoses is concerned and specifically with respect to rabies, no economic evaluations have been conducted so far.

**Annual rabies intervention cost in TN (Rs crore)**

<table>
<thead>
<tr>
<th>Intervention Type</th>
<th>Cost (Rs crore)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vaccine (Oral)</td>
<td>59.0</td>
</tr>
<tr>
<td>Vaccine (Inj)</td>
<td>123.0</td>
</tr>
<tr>
<td>Vaccine Only</td>
<td>3.6</td>
</tr>
<tr>
<td>Vaccine + IgG</td>
<td>11.9</td>
</tr>
</tbody>
</table>

**Figure 2:** Depicts the cost mismatch between human and animal interventions

Additionally, while canine vaccination was a suggested strategy of choice towards elimination of rabies, there was not enough documentation to indicate expectations of local communities or rabies control programme managers, with respect to how the strategy would work. Modelling of pilot canine vaccination interventions in India too showed that a coverage of 70% would have to be sustained over two decades before the intervention could be found effective. Besides, unless accompanied with dog population control, the strategy would unlikely reduce number of dog bites or costs of PEP.

The study clearly brought out the need for researchers and policy-makers to jointly promote evidence-based policy-making in their effort to implement rabies control efforts in the country. A first step for this would be to undertake systematic economic evaluations with respect to rabies.

**The Role of Economic Evaluations in India**

In the domain of health and healthcare, economic evaluations help assess the efficiency of interventions which can help policy makers and programme managers to make informed decisions. Where zoonoses is concerned and specifically with respect to rabies, no economic evaluations have been conducted so far.

---

Are traditional economic evaluation methods appropriate?
Though there is a strong case for the use of economic evaluation methods to allow a holistic and comparative assessment of the impact of zoonoses across sectors, currently there is no methodological approach that allows a simultaneous evaluation from the perspective of more than one sector.

A major barrier to the One Health approach to prevent and control rabies, relates to opaqueness of costs and benefits accrued in all sectors from implementing an intervention in one sector. While some rabies control interventions have impact in a single sector (treating human cases of disease), others have wider impact (Canine Vaccination & Animal Birth Control (ABC-AR)). Economic evaluations of rabies control interventions usually incorporates costs from multiple sectors but while analyzing outcomes from the perspective of a single sector. In a scenario where returns from investment in one sector might benefit others, this limitation of economic evaluation methods prevents decision makers from understanding the larger scenario of costs and benefits of rabies and its interventions across sectors.

RCZI is of the view that traditional economic evaluations may not adequately capture overlapping costs or benefits of rabies as a zoonotic disease. However, creation of a new tool can be an innovative way to produce a comparative assessment of impact of zoonotic diseases across sectors, using existing sector-specific metrics, but with an overarching evaluative framework.

The Gates Grand Challenge
The Multi Criteria Decision Analysis Approach is a widely used analytical method in the disciplines of operations research, natural sciences as well as in considering stakeholder concerns in health evaluations. It offers different ways to aggregate information from multiple sources, like quantitative scoring of different values to get a total impact score or qualitative performance matrix.

Under the Gates project, namely, “Use of Multi-Criteria Decision Analysis to assess impacts of rabies, brucellosis and their interventions”, the PHFI/RCZI research team set out to adapt the Analysis to develop a framework that could measure and analyse costs and benefits of rabies interventions. Instead of having a common metric, this adapted Approach will have the potential to allow for sector-specific metrics that can be used to measure impact across sectors. The feasibility of this evaluation framework will further be discussed and finalised at a follow-up stakeholder meeting later in 2015.

Specifically, the Gates project aims to:
• Develop a novel methodological framework that will allow costs and benefits of rabies and their interventions to be simultaneously evaluated from the perspectives of different stakeholders
• Use an integrated dataset, the architecture of which will be developed for the first time
• Enable application of Multi Criteria Decision Analysis in zoonoses, also for the first time

Once the practical feasibility of the novel techniques proposed in the project are demonstrated, these will be documented in the form of peer reviewed publications.

Aims & Objectives of the Meeting
The RCZI team agreed that a preliminary step to finalising a framework for such an evaluation, would be to get acquainted with recent epidemiological or economic research, programme and policy work, data and expert knowledge of rabies management within India. Additionally, it would be critical to establish better understanding of the current relationship between sectors, with regard to rabies management. These steps must necessarily prelude the adoption of a successful One Health Approach to managing rabies.

Against this backdrop, PHFI/RCZI organised a brainstorming meeting on 16th January, 2015 to discuss recent developments on rabies epidemiology and research of rabies in India, to support the assessment and evaluation of impact of rabies interventions in multiple
Recent Developments in Rabies

It aimed to discuss modalities of joint decision making through visualisation of costs and benefits of rabies control interventions to multiple sectors simultaneously. It would do this while validating the proposed methodology of developing a novel method for epidemiologic and economic evaluation to allow cumulative impact assessment of interventions across livestock, canine, wildlife and human sectors.

Experts included representatives from the Federation of Indian Animal Protection Organisations, Indian Veterinary Research Institute, Help in Suffering, Guru Angad Dev Veterinary and Animal Sciences University Madras Veterinary College, Kempegowda Institute of Medical Sciences, Wildlife Institute of India, Animal Welfare Board of India, University College of Medical Sciences, Vets Beyond Borders and the Public Health Foundation of India. Specifically, the meeting aimed to:

- Discuss current knowledge around transmission dynamics due to rabies within and across human, canine, livestock and wildlife species.
- Share existing knowledge on feasibility, effectiveness and sustainability of interventions for rabies control within and across sectors.
- Outline possible roles of different stakeholders in financing, designing and implementation of different rabies control interventions as part of a comprehensive rabies control strategy in India.

Organisation of the Meeting

The meeting comprised of the three major discussion threads focusing around transmission of rabies, management of rabies and costs and benefits of rabies control in India. These discussions were conducted as parallel breakaway sessions lasting 60 minutes in small groups followed by short presentations and a plenary discussion. Participants were divided into three sector/species and assigned to specific groups who were given Terms of Reference (ToRs) and prompts to facilitate discussion (See Annexures).

The three working groups were categorised as Canine and Wildlife, Livestock and Human and within these broad sectors, discussions focused on transmission dynamics, surveillance issues, management of rabies and the cost and benefits of select interventions. They also discussed current knowledge around transmission dynamics due to rabies within and across human, canine, livestock and wildlife species.
There has been divided opinion on whether rabies is more endemic in the canine population in rural or urban settings. This has further led to discussion on factors of rabies transmission in these settings. Key factors such as dog population, dog density, dog-to-human ratio, dog-to-livestock ratio, geographical spatial territory of dogs and solid waste management in rural and urban settings are some of the factors that affect transmission of rabies.

Dogs have been known to be the host reservoir where the rabies virus demonstrates greatest transmission. Although there has been debate on the type of canines and whether wild animals such as jackals, foxes and hyenas can be classed as canines, there is a universal consensus that majority of transmission of rabies is due to stray dogs, with approximately 60% stray dogs and 40% pet dogs.

It has also been estimated that approximately 2% of human rabies cases are due to cats. While cat bites are reportedly increasing in numbers, experts opined that the cat population is not currently significant within the overall rabies transmission scenario.

**Surveillance of Rabies in Canines**

Experts felt that two types of surveillance data were needed to understand transmission of rabies in canines. The first related to the demographic characteristics of dogs and the second to disease characteristics of rabies in dogs.

It was pointed out that currently, there were no current surveillance systems for disease in canines. However, some localised NGO’s measured data on dog demography whereas others recorded rabies characteristics in dogs. Specific NGO’s that do collect data include the ABC-AR programme implemented by Help in Suffering in Jaipur, surveillance work conducted by Tamil Nadu Government, mass ABC-AR carried out in Haryana by the Animal Welfare Board of India (AWBI), the Sikkim Anti-Rabies and Animal Health (SARAH) organisation and the Mumbai-based NGO, Welfare of Stray Dogs.
Transmission Dynamics of Rabies in Canines

From discussions, it emerged that canine interventions have been followed for a long time and canine vaccinations regarded as a gold standard globally. In India, due to the large stray dog population, this is seen as a cumbersome exercise which is unlikely to reduce number of bites in the human population. In recent years, there has been growing consensus that canine vaccination should be coupled with dog population management. Culling is also viewed as an intervention though in India, it is considered illegal and as an act of cruelty to animals.

Management of Rabies in Canines

Currently the recommended control measure for rabies is canine vaccination. Other interventions that can be considered include Canine Vaccination (ARV), ABC-AR, solid waste management in urban and rural areas, education programmes on rabies infection and behavioural changes towards the dog population. Although other contexts have shown canine vaccination to be the gold standard in the eradication of rabies, a recent published article suggested that canine vaccination may not be altogether sustainable and animal birth control would also need to be included.17

The recommendation that emerged was that ABC-AR should be conducted instead of just canine vaccination. Another possible solution would be to mount a joint effort that included other interventions in the human sector and within the livestock/canine sector.

Examples of mass vaccination campaigns

- Data from Mumbai revealed that in 1994, dog bites were to the tune of 40-50,000. This went up to 60,000 and then plummeted to 40,000 in 2006 before going up again, because of non availability of vaccines.

- A mass vaccinations campaign was launched in Sikkim with efforts to cover 70% dogs. Up till 2010 cases went down proving that mass vaccinations camps were an effective intervention.

- Mission Rabies was launched by Worldwide Veterinary Services who vaccinated 60,000 dogs (Sept-Nov 2013) in the country. On the side, the ABC AR programmes were being conducted and combined with re-vaccinations. Data is yet to be made available but the intervention is expected to register some impact.
The focus of discussions was on identifying populations and settings that demonstrated increased transmission of rabies in India; factors contributing to continued transmission of rabies between canines and other species; comparison of demographic characteristics of canines with wildlife reservoirs; and existing surveillance systems for demographic and disease surveillance amongst canine and wildlife for rabies.

**Transmission Dynamics of Rabies in Wildlife**

Wildlife experts admitted that the biggest constraint in studying rabies in wildlife in India was the absence of information on transmission. They pointed out that while there was some amount of natural transmission of the rabies virus within wildlife, a generally accepted fact was that wildlife was not a major source for introducing infection within domestic animal species or livestock.

Among wildlife species, jackals, foxes, hyenas, wolves, leopards, mongooses and bats were considered likely reservoirs of the virus. However, due to lack of demographic research and characteristics of wildlife and rabies in wildlife, it was difficult to justify the claim completely. Some of the key concerns in the wildlife sector related to there being virtually no studies in rabies in wildlife. This was partly due to this being an expensive proposition since there was lack of incentive to do this kind of research and the extreme difficulty in undertaking proper research in the wild. In addition to there being an unknown and probable reservoir from where there has been spillover of rabies into dogs (hyenas, leopards, etc), there are behavioural patterns in lifestyles of wild animals that tend to affect their likelihood to spread rabies.
Factors that influence transmission

**Dog-to-human population density:** As far as indicators in wildlife are concerned, it is difficult to make an accurate assessment. A proper robust surveillance system, such as reporting, regardless of consequences is required. There have to be different indicators for different sectors and the key would be to see how these indicators for wildlife are determined. The wildlife sector must be in a position to decide its priorities while keeping in mind that so far there has been no pressure to push for a strategy or intervention until something happens at scale demonstrating impact upfront.

*Rabies in wildlife is not a visible disease. There are inherent issues as far as wildlife is concerned. It is only recently that decision makers, such as forest officials have begun realising value of research data. Scientists earlier viewed diseases as part of the natural ecosystem and concluded that there was no need for interventions. Impact of zoonotic disease outbreaks on humans and livestock in recent years has led to some change in thinking.*

**Transmission is influenced by the setting:**
The setting could be rural or urban human habitations closer to forest areas or at sites where there is unplanned development and increased potential for animal-human contact. Since many rural settings are close to wildlife settings, there is larger risk of transmission between canines and wildlife. This is likely to increase transmission in livestock and humans.

*Presently, scenarios of both dogs and wildlife are being disrupted. Decline of vultures has led to increase in dog population and change in dog behaviour has led to increase in human bites (because vultures are no longer involved in carcass disposal). Urban development has disrupted wildlife populations which are coming closer to humans leading to, amongst other things, greater rabies transmission. An increased dog population and an altered wildlife population has also led to an increase in their interactions.*

The Ebola crisis has shown serious impact on public health, economies and societies. The outbreak in West Africa has been unprecedented in scale and impact. Majority of emerging infectious diseases have their source in animals and emergence occurs at the human/animal interface, when infections in animals breech the species barrier to infect humans, population in which they are often first identified. The response is frequently characterised by a series of emergency activities to contain and manage the infection in human populations and at the same time identify the source of infection in nature. Currently, efforts are being undertaken for closer interaction at the animal/human interface through joint surveillance and risk assessment between animal-human-medicine sectors. In addition to essential community and policy-oriented actions around strengthening preventive public health infrastructure, a more integrated view and approach to human, animal and environmental health must be taken. This broader view of health that moves beyond single-species perspective, to ecosystems as a whole, will be critical in dealing with future outbreaks.

Deforestation could be a factor in influencing transmission: Deforestation can result in loss of habitat or change in the population of prey species, influencing transmission of rabies within wildlife carnivores. Wildlife experts argue that a larger cause could be the loss of prey species and not necessarily deforestation.

Surveillance of Rabies in Wildlife
Currently there are no surveillance systems in place to understand the burden of rabies in free-ranging wildlife in India. Systematic surveillance is needed to make responsible decisions. The difficulty in implementing surveillance in wildlife translates into large costs that are needed to design and implement such a system. It would also be useful to procure data of vaccine use in captive wild animals from zoos and other organised wildlife habitats.

Management of Rabies in Wildlife
India lacks any interventions on control of rabies in wildlife. Studies in other international contexts show that oral vaccinations have been used as an intervention to decrease the burden of rabies in wildlife. It has also been seen that wild animals in confinement are administered rabies vaccine on yearly basis. This rabies vaccine has been the same as the one used on dogs with dosage being increased when used on wild animals and calculated on basis of size.

Select global examples seen across research studies include:
- Oral vaccinations have been used as an intervention to decrease burden of rabies in wildlife
- Role of scavengers in wildlife food chain can result in greater population of species that influence transmission of rabies
- Role of canine vaccination in areas close to wildlife proximity is considered another intervention based on studies conducted in Tanzania

Key concerns expressed by wildlife experts related to administering the rabies vaccine to major carnivores in captive wildlife. According to these experts, this is done to minimise risk to them and to other animals in captivity, especially when they come in contact with animals like mongoose, who can go everywhere. A significant point to note is that while there are annual vaccination programmes for wildlife confined in a zoo, there are no interventions for free-ranging wildlife.

Decrease in population of vultures in India would create a larger food source for scavenger wildlife such as hyenas or stray dogs. This would increase population of hyenas or stray dogs, thereby resulting in a change of transmission of rabies.

The Inter & Intra Costs & Benefits of Rabies Control in Wildlife
Wildlife experts expressed their concern saying that the absence of evidence of rabies in wildlife in India made it difficult for the wildlife sector to comment on the level of input it should have within rabies prevention and control.
They emphasised the relevance and importance of more research to be undertaken, especially with respect to rabies related aspects in wildlife, along with few immune response studies. They expressed their keenness to collaborate on the research of zoonotic diseases in wildlife with other sectors and partners.
Views were shared on the distribution of burden of rabies amongst livestock in India, factors which contribute to continued transmission of rabies to the livestock population and current surveillance systems for demographic and disease surveillance amongst livestock population for rabies.

**Transmission Dynamics of Rabies in Livestock**

Talking of transmission from livestock to other species, it was shared that there has been negligible transmission between livestock. Milk has been identified as a source of transmission, although biological evidence does prove that milk, when consumed by calves is not likely to result in infection. Transmission from livestock to humans too has been found to be minimal. The saliva to the dairy farmers has been cited as another source of transmission, but is not seen as a major source of transmission to humans for rabies. Other aspects of rabies transmission in livestock that were identified included smaller ruminants such as sheep and goat. They were more likely to be bitten than larger livestock (horses or cattle).

**Patterns of infection amongst tied and free-ranging livestock:** Tied animals were likely to be less exposed but more vulnerable while free ranging animals were more exposed and less vulnerable. Experts felt that certain high value livestock such as horses and some dairy cows might be more likely to be vaccinated against rabies due to value of the specific animal.

*Transmission dynamics vary as per setting and geographical area:* Amongst livestock, some differences were found in rural versus urban transmission of rabies amongst livestock. Density of livestock and how animals were kept (tied or free) also had an impact on transmission dynamics.

*Tied animals have greater chance of getting bitten since they cannot move and protect themselves from stray dogs and untied means they might be more exposed in terms of geographical areas. Overlapping farms could be another factor. In a large farm, there is greater chance of getting more bites as opposed to smaller farms where likelihood of a particular species getting bitten by a dog is relative less.*
**Sources of infection to animals:** For all livestock, there is no specie-specific post exposure or pre-exposure vaccine. The vaccine used in dogs tend to be scaled up based on size of the livestock and the dosage that is administered. In terms of sources of infection to animals (rural or urban), dog bites were acknowledged as a major source with a small source of infection seen from wild sources, such as jackals. It was pointed out that a mongoose biting large animals while they were grazing could be a common occurrence although they are not a significant source of infection.

**Surveillance of Rabies in Livestock**
A national surveillance system of rabies within livestock exists in the country despite of rabies not being a priority disease within the animal sector and surveillance data being inconsistent.

Potential animal data on rabies through clinics and/or veterinary colleges is available and must be tapped. One reason for lack of data is due to the slaughter of livestock who earlier contracted rabies. These episodes normally do not tend to get reported since animals get mostly slaughtered or killed in rural areas. This often leads to a situation where there is no confirmed estimate of the total number of bites or extent of rabies in livestock.

Further, larger livestock who are more economically valued may be given a rabies PEP after a bite wound depending on severity of the wound, whereas smaller livestock may either be sold for slaughter or slaughtered immediately.

**Key concerns**
- This is not a reportable disease and no one is really is keen on finding out the extent of the problem
- Diagnostic facilities are mostly directed towards the urban side, making data very limited

Experts urged concerned departments to procure reliable data on doses and to estimate costs of PEP which are prohibitive in livestock.

**Management of Rabies in Livestock**
Livestock experts felt that the only inexpensive and effective intervention that could be used in the case of livestock was that of PEP. Rabies which was seen as a single animal disease and not a herd disease was essentially because it was not easily transmitted between animals/livestock.

In the current situation where India is more focused on animal productivity as opposed to animal welfare, there remains a larger population that recognises food source a major issue. Developed countries on the contrary are already taking into account animal welfare. With a large population to feed, productivity of livestock needs to be given greater priority.

Greater conviction is also required amongst the rabies community before interventions are implemented within the canine sector and for benefits to be seen in the livestock sector. Livestock sectors specified that access to PEP, its supply and lack of information of what to do after a bite to livestock was a theoretical factor which further accentuated possibility of rabies transmission.

**The Inter & Intra Costs & Benefits of Rabies Control in Livestock**
While discussing the costs and benefits of rabies, experts felt that the design and implementation of rabies prevention and control strategies relating to canine vaccination and ABR should be conducted by veterinarians. However, experts within animal sectors suggested that larger investments must come from the human sector due to the direct benefits that are accrued within the same.
Recent Developments in Rabies

A general reaction was that with respect to economic burden of rabies, other diseases always get priority over rabies. Even though estimated costs to the farmer, to treat each animal could be in the prohibitive range of Rs50,000-60,000, it still does not emerge as a major concern that can draw the attention of policy makers.

In terms of primary mandates regarding rabies intervention control, interesting insights were presented on how priority lists change from the animal sector as a whole, with higher priority diseases finding their way on the list, edging out rabies or placing it low in the agenda.
Human sector experts discussed existing surveillance systems for dog bites in humans and human rabies surveillance and categorisation of dog bites and current programmes that collect this data. They also talked of the changes witnessed in the epidemiological picture in the last decade and its contribution to rabies transmission in humans along with factors that have contributed to creating hotpots of rabies epidemics in India.

Transmission Dynamics of Rabies in Humans

It was pointed out that earlier studies had mostly assessed the human burden without assessing the epidemiological transmission between species or the burden on livestock. An acknowledged fact has been that the context of rabies transmission in humans is directly associated with dogs. Experts agreed that previous data which showed a higher burden of rabies in rural areas could not be relied upon to depict the true scenario of rabies in the country and that further research was needed to understand transmission dynamics of rabies in rural and urban contexts.

Factors associated with settings which could contribute to a change in transmission meanwhile included the level of education amongst nationals, human density, a high human and dog density, extent of awareness of rabies prevention and control and the various behavioural characteristics that prevailed in urban and rural settings (role a stray dog plays to a human population in different settings and human access to PEP).

Peri-urban areas on the fringes of cities and urban areas in cities in India are yet to be understood with regard to rabies transmission. Due to rapid development in the past decade, they now play an important role in rabies transmission and must therefore merit greater attention.

Surveillance of Rabies in Humans

Experts highlighted key sources of information regarding data on rabies in humans in India, such as:

- Dog bite data within humans which can be sourced from the Integrated Disease Surveillance Programme (IDSP)
- Human rabies data which can be collected by infectious disease hospitals or wards, though this would not be a true incidence of rabies within humans
- Some clinical studies that have been published in journals such as Association for Prevention & Control of Rabies in India (APCRI) can provide valuable information
- Report published by World Health Organisation (WHO) Expert Consultation, 2013 can serve to guide and inform
The discussion brought to the fore many incidences of misreporting which may have been due to hospital or clinic staff using outdated WHO recommended guidelines that had been issued to hospital staff nearly a decade ago.

This necessitated the urgency to create/update Standard Operating Procedures to advice physicians on diagnosis and treatment of rabies in humans.

Management of Rabies in Humans

Human rabies experts agreed that even if ABC-AR or just canine vaccination were seen as costly yet effective interventions, PEP must still be used in dog bites in humans. No doubt, access to PEP, PEP efficacy, lack of availability of PEP may all be factors that could influence transmission.

It would be therefore important to have guidelines that describe the methods for rabies control in humans and update these, especially, in light of evidence generated over the last decade. Also, currently the criteria being used relates mostly to WHO recommended guidelines which have been issued to hospital staff nearly a decade ago. There is need to create fresh Standard Operating Procedures to advice physicians on diagnosis and treatment of rabies in humans.

The annual conferences of the Association of Prevention and Control of Rabies in India (APCRI) have many useful presentations from medical colleges and elsewhere. They do not always find a way into the public domain. It may be prudent for RCZI to depute someone to attend them and capture the latest information on rabies, which is otherwise is not available from sources like PubMed and Google Scholar. Another reliable source would be to go to APCRI Journal for papers on rabies and categorisation of bites.

The Inter & Intra Costs & Benefits of Rabies Control in humans

Human rabies experts initially felt that sector-based prevention and control would be achievable but not without joint coordination to eliminate wastage of resources and to increase efficiency.

Human rabies experts advocated for the development of better and more recent guidelines which could be in line with recent findings and studies to help rabies control efforts. They felt a joint-sectoral strategy was possible and it could be implemented once it had data and research to build a case for it.
Lastly, as a small exercise, experts were asked to list measures which could be used to determine the effectiveness of an intervention in different sectors. Some suggested indicators that could be used to measure effectiveness of interventions are as follows:

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Sector</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incidence of rabies in dogs</td>
<td>Canine</td>
</tr>
<tr>
<td>Dog Density</td>
<td>Canine</td>
</tr>
<tr>
<td>Dog population</td>
<td>Canine</td>
</tr>
<tr>
<td>DALYs</td>
<td>Human</td>
</tr>
<tr>
<td>Incidence of human rabies</td>
<td>Human</td>
</tr>
<tr>
<td>Incidence of dog bites in humans</td>
<td>Human</td>
</tr>
<tr>
<td>% of bite cases in humans that have completed a full course of PEP</td>
<td>Human</td>
</tr>
<tr>
<td>% of bite cases in humans that have a history of wound wash (water vs water + soap).</td>
<td>Human</td>
</tr>
<tr>
<td>Time interval between bite and intervention</td>
<td>Human</td>
</tr>
<tr>
<td>Time interval between bite and wash</td>
<td>Human</td>
</tr>
<tr>
<td>Increase in the usage of ARGs</td>
<td>Human</td>
</tr>
<tr>
<td>% of clinics with uninterrupted availability of vaccines</td>
<td>Human</td>
</tr>
<tr>
<td>Human: Dog Ratio</td>
<td>Human/Canine</td>
</tr>
<tr>
<td>Improved knowledge on rabies</td>
<td>Human/Livestock</td>
</tr>
<tr>
<td>Death</td>
<td>Human/Livestock/Wildlife</td>
</tr>
<tr>
<td>Cost savings made by sharing resources</td>
<td>Human/Livestock/Wildlife</td>
</tr>
<tr>
<td>Incidence of livestock rabies</td>
<td>Livestock</td>
</tr>
<tr>
<td>Incidence of dog bites in livestock</td>
<td>Livestock</td>
</tr>
<tr>
<td>Livestock deaths due to rabies</td>
<td>Livestock</td>
</tr>
<tr>
<td>Livestock deaths due to dogs</td>
<td>Livestock</td>
</tr>
<tr>
<td>Livestock Productivity</td>
<td>Livestock</td>
</tr>
<tr>
<td>Livestock handler deaths from dogs</td>
<td>Livestock/Human</td>
</tr>
<tr>
<td>Biodiversity</td>
<td>Wildlife</td>
</tr>
<tr>
<td>Deaths in wildlife</td>
<td>Wildlife</td>
</tr>
<tr>
<td>No of wild scavenger deaths</td>
<td>Wildlife</td>
</tr>
<tr>
<td>No of large wildlife deaths</td>
<td>Wildlife</td>
</tr>
</tbody>
</table>
Recent Developments in Rabies

Recommendations generated from the meeting focused on three broad categories, namely research agenda, programme implications and subsequent workshops.

A common thread that emerged from all experts was the need for mapping gaps in research with regard to control of rabies. The meeting chiefly helped elicit key areas of research which institutions could look to follow up on, for rabies prevention and control. A research agenda was highlighted as a must-do for the veterinary health/wildlife and environment/human health sectors.

**Veterinary Health Rabies Research Agenda**

- Conduct studies on dog demography, dog ecology and transmission dynamics of rabies in canines
- Understand transmission dynamics of rabies in canines and livestock in urban and peri-urban contexts and elicit impact of urbanisation on transmission of rabies.
- Quantify burden of rabies in canines
- Quantify burden of rabies in different species of livestock and understand factors that influence rabies transmission in livestock
- Understand impact of rabies on the economic productivity of livestock owners

**Wildlife & Environment Rabies Research Agenda**

- Conduct studies on the demography and susceptibility of wildlife to the rabies virus
- Understand transmission dynamics of rabies in wildlife and the impact rabies has on the ecology of wildlife
- Understand impact of urbanisation on wildlife habitats and the resulting change in rabies transmission dynamics
- Conduct impact evaluations for solid waste management
- Understand how solid waste management and appropriate carcass disposal influences transmission dynamics
- Elicit key risk factors that contribute to wildlife rabies spillover in livestock, canines and humans

**Human Health Rabies Research Agenda**

- Understand socio-cultural and behavioural factors in humans that contribute to transmission of rabies
- Conduct health economic studies regarding cost-effectiveness of interventions and economic analysis of health policy for rabies
- Quantify level of access of human PEP in different Indian contexts and impact of increased coverage and access
- Revisit current guidelines of rabies prevention and control and update them in light of recent advances in rabies research

**Programme Implications & Subsequent Workshops**

A unanimous objective that was emphasised by all sectors was to build a coordinated response to rabies control. The view was that this would
happen only when the concerned sectors had re-evaluated their roles and realigned their interests, taking into account overlapping costs and benefits of rabies control.

Experts felt that research that was currently being carried out needed more focus with potential to feed into policy discussions. This became even more applicable for livestock and wildlife sectors, where practically no research has been conducted with respect to rabies.

The brainstorming meeting had clearly achieved a certain level of understanding amongst the sectors with clarity on roles and the kind of commitments they could make to rabies control and prevention. These would need to be revisited at a follow-up meeting which could be organised in 2016 with the broad agenda to:

- Assess a nationally relevant disease transmission and evaluation model
- Elicit differing priorities and opinions of multiple stakeholders for prevention and control of rabies
- Quantify level of contribution required from different sectors
- Understand efficiency of an intervention in different sectors
- Map and conduct focused research with potential to feed into policy discussions
The meeting brought together experts from the three domains, opening up the discussion in a way that allowed different dimensions of rabies prevention and control to be viewed. The meeting proved to be a good brainstorming exercise with experts from the wildlife, canine, livestock and human health side sharing their experiences, concerns and ideas providing a lot of clarity on transmission dynamics and epidemiology related aspects of rabies prevention and control. The discussions threw light on some of the routes of transmission of rabies within and across sectors, the role dogs are playing within this and, how the virus is flowing from the different species as a source of infection to other species.

Despite lack of evidence across sectors, experts could contribute to establishing better understanding of the issues and press for a case for joint-sectoral coordination in order to bring greater feasibility, effectiveness and sustainability of interventions. Some of the challenges on the human rabies component were taken up with interesting insights from stakeholders on the financing and the different options that have come into play.

The group resolved to reconvene after a few months with a better analysis of the findings of the meeting and an outline of some of the studies and systematic reviews that can be taken up to identify knowledge gaps, prioritise those knowledge gaps and have a long-term response programme on rabies.

The meeting succeeded in navigating around some of the complexities that surrounded rabies control, prevention and costing related aspects, moving forward towards the goal of developing more effective, acceptable and sustainable policy solutions.


13. Sekar N, Shah NK, Abbas SS, Kakkar M. Research options for controlling zoonotic


Annexures

Abbreviations

ABC – Animal Birth Control
ABC-AR – Animal Birth Control – Anti Retroviral
APCRI – Association for the Prevention and Control of Rabies in India
AWBI – Animal Welfare Board of India
IDSP – Integrated Disease Surveillance Project
NGO – Non Governmental Organisation
PHFI – Public Health Foundation of India
SARAH – Sikkim Anti Rabies & Animal Health Division
WHO – World Health Organisation
WSD – Welfare of Stray Dogs
## Agenda

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.30</td>
<td>Registration/Refreshments</td>
</tr>
<tr>
<td>10.00</td>
<td>Welcome &amp; Introduction of Participants</td>
</tr>
<tr>
<td>10.40</td>
<td>Introduction to the Meeting</td>
</tr>
<tr>
<td>10.50</td>
<td>One Health Metrics for Rabies: Context Setting</td>
</tr>
<tr>
<td>10.50</td>
<td>An Overview of the Methods used in Rabies Transmission &amp; Cost Effectiveness</td>
</tr>
<tr>
<td>11.10</td>
<td>Introduction to Parallel Session 1</td>
</tr>
<tr>
<td>11.15</td>
<td>Tea/Coffee &amp; Refreshments</td>
</tr>
<tr>
<td>11.30</td>
<td>Parallel Session 1 - Transmission of Rabies in India</td>
</tr>
<tr>
<td>12.30</td>
<td>Group presentations (5 + 5 mins x 3), Synthesis &amp; Discussion</td>
</tr>
<tr>
<td>13.00</td>
<td>Lunch</td>
</tr>
<tr>
<td>14.00</td>
<td>Parallel Session 2 - Management of Rabies in India</td>
</tr>
<tr>
<td>15.00</td>
<td>Group Presentations, Synthesis &amp; Discussion</td>
</tr>
<tr>
<td>15.30</td>
<td>Tea/Coffee &amp; Refreshments</td>
</tr>
<tr>
<td>15.45</td>
<td>Parallel Session 3 - Costs &amp; Benefits of Rabies Control</td>
</tr>
<tr>
<td>16.45</td>
<td>Group Presentations, Synthesis &amp; Discussion</td>
</tr>
<tr>
<td>17.45</td>
<td>Conclusion</td>
</tr>
<tr>
<td>18.00</td>
<td>Dinner</td>
</tr>
</tbody>
</table>
# List of Participants

<table>
<thead>
<tr>
<th>Name</th>
<th>Organisation</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abodh Aras</td>
<td>Federation of Indian Animal Protection Organisations</td>
<td><a href="mailto:abodh.a@gmail.com">abodh.a@gmail.com</a></td>
</tr>
<tr>
<td>Ashok Kumar</td>
<td>Indian Veterinary Research Institute</td>
<td><a href="mailto:ashokakt@rediffmail.com">ashokakt@rediffmail.com</a></td>
</tr>
<tr>
<td>Hiral A. Shah</td>
<td>Public Health Foundation of India</td>
<td><a href="mailto:hiral.shah@phfi.org">hiral.shah@phfi.org</a></td>
</tr>
<tr>
<td>Jack Reece</td>
<td>Help in Suffering</td>
<td><a href="mailto:jack@his-india.in">jack@his-india.in</a></td>
</tr>
<tr>
<td>JPS Gill</td>
<td>Guru Angad Dev Veterinary and Animal Sciences University</td>
<td><a href="mailto:gilljps@gmail.com">gilljps@gmail.com</a></td>
</tr>
<tr>
<td>L Gunaseelan</td>
<td>Madras Veterinary College</td>
<td><a href="mailto:hodvphmvc@tanuvas.org.in">hodvphmvc@tanuvas.org.in</a></td>
</tr>
<tr>
<td>Manish Kakkar</td>
<td>Public Health Foundation of India</td>
<td><a href="mailto:manish.kakkar@phfi.org">manish.kakkar@phfi.org</a></td>
</tr>
<tr>
<td>MK Sudarshan</td>
<td>Kempegowda Institute of Medical Sciences</td>
<td><a href="mailto:mksudarshan@gmail.com">mksudarshan@gmail.com</a></td>
</tr>
<tr>
<td>PK Malik</td>
<td>Wildlife Institute of India</td>
<td><a href="mailto:malikpk@wii.gov.in">malikpk@wii.gov.in</a></td>
</tr>
<tr>
<td>RM Kharb</td>
<td>Animal Welfare Board of India</td>
<td><a href="mailto:awbi@md3.vsnl.net.in">awbi@md3.vsnl.net.in</a></td>
</tr>
<tr>
<td>Sanjay Chaturvedi</td>
<td>University College of Medical Sciences</td>
<td><a href="mailto:cvsanjay@hotmail.com">cvsanjay@hotmail.com</a></td>
</tr>
<tr>
<td>Sudhir Satpathy</td>
<td>NRI Institute of Medical Sciences</td>
<td><a href="mailto:sudhirksatpathy@gmail.com">sudhirksatpathy@gmail.com</a></td>
</tr>
<tr>
<td>Syed S. Abbas</td>
<td>Public Health Foundation of India</td>
<td><a href="mailto:syed.abbas@phfi.org">syed.abbas@phfi.org</a></td>
</tr>
<tr>
<td>Thinlay Bhutia</td>
<td>Vets Beyond Borders</td>
<td><a href="mailto:thinlay@vetsbeyondborders.org">thinlay@vetsbeyondborders.org</a></td>
</tr>
</tbody>
</table>
PARALLEL SESSION 1 ToRs: 
Transmission Dynamics of Rabies

**Group A: Canine & Wildlife**

**Terms of Reference**
1. Identify populations and settings that demonstrate increased transmission of rabies within India.
2. Discuss and list other factors that are contributing to continued transmission of rabies between the canine population and other species.
3. Compare the demographic characteristics of canines with wildlife reservoirs identified earlier.
4. List and describe current surveillance systems for demographic and disease surveillance amongst the canine and wildlife population for rabies.

**Prompts**

ToR 1: Are certain geographic or ecological locations more likely to demonstrate increased transmission of rabies? Among wildlife which species are more likely to maintain and transmit rabies virus? A recent paper states, "Given the relatively close phylogeny between rabies virus variants of the Indian dog and arctic fox, the role of wildlife in maintaining rabies in India should be thoroughly studied. For human rabies, contacts with jackals, cats, monkeys, mongooses and foxes were found to be associated with 1.7, 0.8, 0.4, 0.4 and 3%, respectively, of the reported cases," \(^1\) Do you agree with the distribution?

ToR 2: In addition to the settings identified previously, are there other factors that influence increased transmission of rabies, such as dog-human density, seasonality, etc.?

ToR 3: Certain modelling exercises assume similar demographic traits for dogs, foxes, jackals and wolves. These traits include similar birth and mortality rates. What is your opinion?

ToR 4: Are you aware of any ongoing programmes that regularly collect information on dog population, rabies surveillance in canines or wildlife?

**Group B: Livestock**

**Terms of Reference**
1. Discuss the distribution of burden of rabies amongst livestock in India by population and settings.
2. Discuss and list other factors that are contributing to continued transmission of rabies to the livestock population.
3. List and describe current surveillance systems for demographic and disease surveillance amongst livestock populations for rabies.

---

Prompts

ToR 1: Are certain geographic or ecological locations more likely to demonstrate increased transmission of rabies? Among livestock, which species are the most susceptible to rabies and which species are more likely to maintain and transmit rabies?

ToR 2: In addition to the settings previously suggested, what other factors could influence transmission of rabies, such as dog to livestock ratio, livestock density, farm size type of farm, etc?

ToR 3: Are you aware of any ongoing programmes that regularly collect information on livestock census data in India, rabies surveillance in livestock or in specific species of livestock?

Group C: Humans

Terms of Reference

1. List and describe current surveillance systems for dog bites in humans and human rabies surveillance.

2. Describe your understanding of the categorisation of dog bites and current programs that are collecting this data.

3. Discuss how the epidemiological picture may have changed over the past 10 years and how this contributes to rabies transmission in humans.

4. Discuss factors that contribute to hotspots of rabies epidemics in India.

Prompts

ToR 1: Are you aware of any ongoing programmes or healthcare facilities that regularly collect information on human dog bite exposure or conduct rabies surveillance and vaccine coverage in humans? Which healthcare facilities within India are key providers of rabies post exposure prophylaxis?

ToR 2: What is the current categorisation of dog bites in India and are there any programs or healthcare facilities that are recording data on categorisation of dog bites in humans?

ToR 3: How has the epidemiological picture of rabies changed over in the past ten years and how has this influenced the transmission of rabies?

ToR 4: Discuss the key influences that have contributed to rabies remaining endemic within India such as geography, demography, social, economic, etc.?
PARALLEL SESSION 2 ToRs: Management of Rabies in India

Group A: Canine & Wildlife

Terms of Reference
1. List 5 interventions and explain 5 key indicators that you would use to measure the effectiveness of these interventions for the prevention or control of rabies within the canine and wildlife sector.

2. Identify recent large scale and well documented programs for rabies prevention or control in canine and wildlife populations and describe the effectiveness of the interventions that are being implemented within these programs.

3. Propose feasible and sustainable solutions for a decrease in incidence of dog bites.

Prompts
ToR 1: What units of measurement would you use to determine the effectiveness of a rabies control program in both canines and wildlife, for example, within the human sector, DALYs could be used?

ToR 2: Are you aware of any ongoing programmes in India that have been active in the prevention and control of rabies in wildlife or canines? If yes, what methods did they use?

ToR 3: A recent paper states, “The costs of a canine vaccination programme is three to 10 times higher than the cost of human prophylaxis. Modelling of pilot canine vaccination interventions in India showed that a coverage of 70% would have to be sustained over two decades in order for the intervention to be effective. In addition, unless accompanied with dog population control, this strategy is not likely to reduce the number of dog bites.” What is your opinion regarding this situation? What other interventions could you suggest that may be feasible, sustainable and reduce the incidence of dog bites within India?

Group B: Livestock

Terms of Reference
1. List and explain 5 key indicators that you would use to measure the effectiveness of an intervention for the prevention or control of rabies within livestock.

2. Identify recent programs for rabies prevention or control within livestock populations and describe the effectiveness of the interventions that are being implemented within these programs.

3. Discuss how access to post exposure prophylaxis for different livestock populations or farms in different geographical settings can influence the control of rabies in India.

**Prompts**

**ToR 1:** What units of measurement would you use to determine the effectiveness of a rabies control program in livestock, for example, within the human sector, DALYs could be used?

**ToR 2:** Are you aware of any ongoing programmes in India that have been active in the prevention and control of rabies in livestock? If yes, what methods did they use?

**ToR 3:** Identify livestock populations and farm geographical settings and their level of access to post exposure prophylaxis.

**Group C: Humans**

**Terms of Reference**

1. List and explain 5 key indicators that you would use to measure the effectiveness of an intervention for the prevention or control of rabies within humans
2. Identify recent programs for rabies prevention or control within human populations and describe the effectiveness of the interventions that are being implemented within these programs.
3. Discuss how access to post exposure prophylaxis for different populations in different geographical settings can influence the control of rabies in India.

**Prompts**

**ToR 1:** Apart from DALYs or mortality, what other units of measurement would you use to determine the effectiveness of a rabies control program in humans?

**ToR 2:** Are you aware of any ongoing programmes in India that have been active in the prevention and control of rabies in humans? If yes, what methods did they use?

**ToR 3:** Identify populations and geographical settings and their level of access to post exposure prophylaxis.
PARALLEL SESSION 3 ToRs:
Costs & Benefits of Rabies Control

Group A: Canine & Wildlife

Terms of Reference
1. Identify your sector’s primary mandate with regards to rabies prevention and control in canines or wildlife.
2. Describe your perspective on which sector should be leading the effort of prevention and control of rabies and why.
3. Discuss possible roles of other sectors in rabies prevention and control

Discussion Prompts
ToR 1: Do you visualize any dissonance between your sector’s primary mandate and its involvement in rabies control? In other words, does the involvement of your sector in rabies related activities, constitute a part of its core mandate? On a related note, in a situation of competing priorities and stretched resources, is it possible to convince departments to implement rabies interventions (such as wildlife surveillance, ABC-AR) when they might not notice immediate benefits to their own departments?

ToR 2: Which agency/agencies should take charge of interventions related to canines? Will reductions in human / livestock mortality be a sufficient motivator for interventions in upstream species (wildlife, canines)? Can you think of other indicators which might influence the activities in your sector? For example, would reductions in livestock mortality be a sufficient motivator for wildlife agencies to implement rabies control interventions in their sector.

ToR 3: Where should the funding and manpower resources for different rabies control interventions come from? Shared equally across sectors, or primarily borne by a specific sector?

Group B: Livestock

Terms of Reference
1. Identify your sector’s primary mandate with regards to rabies prevention and control in canines or wildlife.
2. Describe your perspective on which sector should be leading the effort of prevention and control of rabies and why.
3. Discuss possible roles of other sectors in rabies prevention and control
**Discussion Prompts**

**ToR 1:** Do you visualize any dissonance between your sector’s primary mandate and its involvement in rabies control? In other words, does the involvement of your sector in rabies related activities, constitute a part of its core mandate? On a related note, in a situation of competing priorities and stretched resources, is it possible to convince departments to implement rabies interventions (such as wildlife surveillance, ABC-AR) when they might not notice immediate benefits to their own departments?

**ToR 2:** Which agency/agencies should take charge of interventions related to canines? What do you think is the impact of animal bites and rabies upon productivity in livestock sector? Can you think of other indicators which might influence the activities in your sector?

**ToR 3:** Where should the funding and manpower resources for different rabies control interventions come from? Shared equally across sectors, or primarily borne by a specific sector?

---

**Group C: Humans**

**Terms of Reference**

1. Identify your sector’s primary mandate with regards to rabies prevention and control in canines or wildlife.
2. Describe your perspective on which sector should be leading the effort of prevention and control of rabies and why.
3. Discuss possible roles of other sectors in rabies prevention and control

**Discussion Prompts**

**ToR 1:** How do you visualise your sector’s role in rabies control among canines and wildlife species?

**ToR 2:** In a situation of competing priorities for all sectors, which agency/agencies should take charge of interventions related to canines? Please explain.

**ToR 3:** Where should the funding and manpower resources for different rabies control interventions come from? Shared equally across sectors, or primarily borne by a specific sector?