Forest Malaria Summary

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Definition of “forest”

Forest is defined as terrain with a tree canopy cover of more than 10% and an area of more than 0.5 hectacres, with a minimum tree height of 5 m

Summarizing hidden risks of malaria in forests

Most studies of forest malaria are focused on local factors associated with malaria transmission. These include:

- Distance from forest
- Impact of deforestation and reforestation
- Effect of forest on microclimate
- Vector bionomics
- *Plasmodium* species survival
- Human activities in forests

Malaria eradication/elimination is impractical without prevention of re-introduction/re-emergence from hidden foci/uncontrolled forest malaria

The problem of malaria in forests is compounded by hidden reservoirs of malaria infections that are not fully addressed

Forest has an influence on:

- Temperature buffering
- Rainfall
- Humidity
- Tree canopy
- Flora & fauna
- High organic content in breeding pools
- Lack of infrastructure

Influence of topographic parameters in forested regions

Forests harbor forest-adapted malaria vectors

Temperature, rainfall, and humidity

Generally trees in the forests add moisture in the air by transpiration and help in lowering temperature, thus increasing precipitation

Vegetation

Vegetation near human habitation increases the population of forest malaria vectors and thus increases malaria transmission

Bodies of Water

Mosquitoes mature in bodies of water (their larval habitat) and disperse according to their flight range

Deforestation

Reduction of dense tree shade increases exposure of vector breeding sites and resting places to sunlight, hence altering vector habitats

It has been predicted that deforestation in central Africa and tropical America might increase malaria, whereas in Asia deforestation would result in reduction in malaria

Deforestation affects malaria transmission depending upon the vector diversity of a particular region

Impact of forest and forestation on vector abundance

Manmade forests (including significantly large plantation areas) or reforestation also cause habitat change and influence malaria vector abundance leading changes in malaria transmission scenarios

Behavior of forest-adapted vector forms

Some non-forest vectors have distinct forest forms

Variation in vector forms is accompanied by differences in vectorial capacity, biting habits and differential resistance to insecticides, thus influencing vector control strategies

Plasmodium species distribution in forested regions

Plasmodium in humans is little influenced by forest factors, as its secondary lifecycle is completed in a homeothem. However, the primary life cycle occurs in an ectothermic vector, which is very much influenced by environment

Plasmodium species have evolved to fit local vectors

Risk of primate malaria to humans in forest regions

The presence of a non-human primate *Plasmodium* species in forest foci poses a constant risk of host switching to nearby human populations due to deforestation

The presence of asymptomatic human reservoirs together with infected monkeys could maintain malaria transmission in a situation where routine malaria surveillance and control are difficult

Parasite reservoir and drug resistance

Stability of malaria transmission in endemic areas is also reported to be associated with asymptomatic *P. falciparum* and *P. vivax* reservoirs

The reservoir plays a very important role in bridging transmission seasons

Plasmodium falciparum and *P. vivax* are reported to be more often associated with drug resistance in forested areas where intensity of malaria transmission is higher and malaria control often neglected

The forested Thai-Cambodia border is believed to be the “epicenter” for the origin of chloroquine resistance and evolution of multidrug resistance

Known malariogenic practices of forest natives

These communities are mostly illiterate, prone to suspicious beliefs, and poor at communicating with malaria control workers

Population migration in forest areas

Populations move within and out of the forest for a variety of reasons and this helps in malaria dissemination

Such movements increase the contact with efficient malaria vectors when night halt is done in the forest

Poor infrastructure and communication

Health infrastructure and surveillance are neglected in remote forest areas

The indigenous population generally relies on the health practices of local faith healers and/or quacks

It is reported that treatment seeking behavior is inversely related to the distance from a health facility and communication problems

People’s conceptions and cooperation

Different perceptions about malaria have been reported among tribal groups in different parts of the world

Generally poverty is the next most important factor in accessing a distant healthcare facility besides illiteracy, superstition, and cultural faith

Surveillance is poor in remote forested areas and presumptive treatment using antimalarials in low doses is taken for all sorts of fever, accelerating the development of drug resistance

Suggestions for overcoming major challenges to curbing malaria transmission in forest ecosystems

Forests escape malaria control efforts mainly due to inadequate roads and poor communinication

Communication infrastructure development should be the first priority as this will open new ways and opportunity to the inhabitants and boost their socio-economic status

In forested borders people often migrate across the borders and carry malaria

Tribals in forest areas, often hidden from the outer world, are generally conservative and reluctant in treatment seeking

Mass screening may be useful in order to assess malaria sero-positivity among communities where asymptomatic malaria prevails and people are less prompt in seeking treatment

Strictly controlled administration of antimalarials with periodic assessment of drug resistance status is suggested in forested areas

Conclusions

Malaria transmission in forest areas is a complex process involving interplay between topographical, entomological, parasitological and human factors

Based on in-depth understanding of the intricate relationship of various parameters, situation specific vector/malaria control strategies can be developed and implemented to address malaria in the forests