**ESTIMATING BURDEN OF JAPANESE ENCEPHALITIS (JE) AND IMPACT OF JE VACCINATION IN 16 COUNTRIES: OUCRU-JE Model**

# Generating cases, deaths, those with disabilities and DALYs:

* In order to estimate the cases, deaths, and DALYs from each vaccination scenario, the following model is used:
  + - Calculated for each , where is age group from 0 to 99 years
    - is symptomatic rate.
    - is the FOI for that location (assumed constant), more detail given below on how these parameters were estimated
    - is the susceptible population of age a under different scenarios as described below.
    - : mortality rate.
    - : get from the age table supplied by VIMC.
    - The acute and chronic weight (currently only use acute encephalitis (0.133) and severe motor plus cognitive impairments due to encephalitis (0.542)) are as supplied by VIMC.
    - In, the symptom is assumed to last for 2.5 weeks.
    - The is calculated to be the same time as the acute, not over the remainder of the time the person is experiencing this symptom (sometimes for the rest of the life)
    - : disability rate.
* Population:
  + Population data: 16 countries population as supplied by VIMC; subnational data from Campbell 2011 (where necessary)
  + Vaccination is assumed to be 100% effective and protection lifelong (to be varied in sensitivity analyses)
  + The population, , in the model above is different for each vaccination scenario:
    - No vaccination: the demographic data from the country from 2000 to 2100 (data supplied by VIMC).
    - Routine scenario: assumed vaccination in the 1st age group. In order to take account of the aging, this proportion will go to a+1 in the next year and so on. The newborn group will continue to be vaccinated as long as the routine vaccination continues.
    - Campaign scenario: The whole population who remain susceptible after the routine vaccination will undergo campaign vaccinations, where age groups from 0 to 14 of the given year were assumed vaccinated based on the coverage proportions. These individuals also continue to age in the population. If there are multiples campaign vaccinations, the next one will vaccinate the leftover of the previous vaccinated population, who will also continue to age. (Further sensitivity will be conducted around whether campaigns should those already vaccinated)

# FOI parameter estimation:

* Data:
  + Age-stratified notification cases from literature search:

1. **Philippines**: Epidemiology of Japanese Encephalitis in the Philippines: A Systematic Review.
2. **China**: Japanese encephalitis in mainland china
3. **India**:
   1. Lowest: sample from the distribution: lognormal(mean = log(0.01), sd = 1)
   2. Medium high: Japanese encephalitis virus remains an important cause of encephalitis in Thailand
   3. High: JAPANESE ENCEPHALITIS IN ASSAM, NORTHEAST INDIA 2000-2002
4. **Pakistan**: sample from the distribution: lognormal(mean = log(0.01), sd = 1)
5. **Cambodia**: Aetiology of acute meningoencephalitis in Cambodian children- 2010-2013
6. **Indonesia**:
   1. Low: Japanese encephalitis virus remains an important cause of encephalitis in Thailand
   2. High: Indonesia\_Confirmation of Japanese encephalitis as an endemic human disease through sentinel surveillance in Indonesia.
7. **Laos:** A Prospective Assessment of the Accuracy of Commercial IgM ELISAs in Diagnosis of Japanese Encephalitis Virus Infections in Patients with Suspected Central Nervous System Infections in Laos.
8. **Vietnam:** A Prospective Assessment of the Accuracy of Commercial IgM ELISAs in Diagnosis of Japanese Encephalitis Virus Infections in Patients with Suspected Central Nervous System Infections in Laos. (due to geography)
9. **Bangladesh:** Hospital-Based Surveillance for Japanese Encephalitis at Four Sites in Bangladesh, 2003–2005
10. **Nepal:** Laboratory-based Japanese encephalitis surveillance in Nepal and the implications for a national immunization strategy. (combined data from western and non-western Terai)
11. **Butan:** Nepal\_Laboratory-based Japanese encephalitis surveillance in Nepal and the implications for a national immunization strategy. (combined data from western and non-western Terai) (due to geography)
12. **North Korea:** Japanese encephalitis virus remains an important cause of encephalitis in Thailand (medium class by Campbell 2001)
13. **Burma:** Japanese encephalitis virus remains an important cause of encephalitis in Thailand (due to geography)
14. **PNG:** Japanese encephalitis virus remains an important cause of encephalitis in Thailand (the same as low Indonesia due to geography)
15. **Srilanka:** Japanese encephalitis virus remains an important cause of encephalitis in Thailand (due to geographic)
16. **Timor-leste:** Indonesia\_Confirmation of Japanese encephalitis as an endemic human disease through sentinel surveillance in Indonesia. (due to geography)
    * Age-stratified population data based on the age group of the notification cases (majorly based on Campbell 2011 and other sources for subnational population) including the information of past immunization.

* Catalytic model:
  + The likelihood of proportion of cases in a specific age group
    - * and are the lower and upper boundary of each age group in the notification cases.
      * is the constant FOI
  + The likelihood of expected cases in a specific age group
    - * is number of susceptible people in that age group => this is defined by the population size by age group in the location and its immunizing program. The population size by age group is the sum of all people in that age group over the time the study conducted
      * is the reporting rate, comprised of symptomatic rate and reporting rate from health system – which may varied between studies.
  + The log multinomial likelihood function for all age groups:
    - * Where is the total cases of all age groups.
  + The multinomial likelihood includes Poisson likelihood of total cases across all age group:
  + We fitted this log-likelihood function in Bayesian framework, with 2 parameters:
  + Estimating in RStan => get the posterior distribution of