TITLE

The Epidemic of Lymphatic Filariasis

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MA 6272 – POPULATION DYNAMICS

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- Diskripsi Filariasis
- Mekanisme penularan
- Fokus pada daerah endemik di mana

Background

Why are we concerned about eliminating lymphatic filariasis?

Lymaphatic filariasis has been identified as the second leading cause of permanent and longterm disability in the world.

With the introduction of the Global LF Elimination Campaign in 1997,the world community is committed to eliminate this desease by 2020.Since LF affects primarily those in poverty, the elimination of the desease will greatly improve the economic potential for those countries where LF is endemic.

Assumption

1. The spread of Lymphatic Filariasis is observed in the close community which vector and host has random interaction
2. Hospes reservoir is ignored
3. Migration is ignored
4. Weather, breeding feed of vector is ignored
5. Vector population is constant
6. All birth of vector is susceptible
7. Host population is constant
8. All birth of host is susceptible
9. Infected host is random

Assumption

12. Infected host is two, which is infected host with sympton and infected host without symptoms

Notations

N_h = Total of human population

S_h = Total of susceptible host

I_h = Total of infected host

K_h = Total of infected host with symtomps

C_h = Total of disability host

N_v = Total of vector population

S_v = Total of susceptible vector

Notations

I_v = Total of infected vector

μ_h = Natural death rate of host per individual per time

μ_v = Natural death rate of vector per individual per time

ε = Natural treatment rate per individual per time

δ = Speed of acute n chronic symptoms is present

θ = Total of infected host who get drug treatment

Notations

α = Speed of drug effectivity

β = Speed of drug effectivity

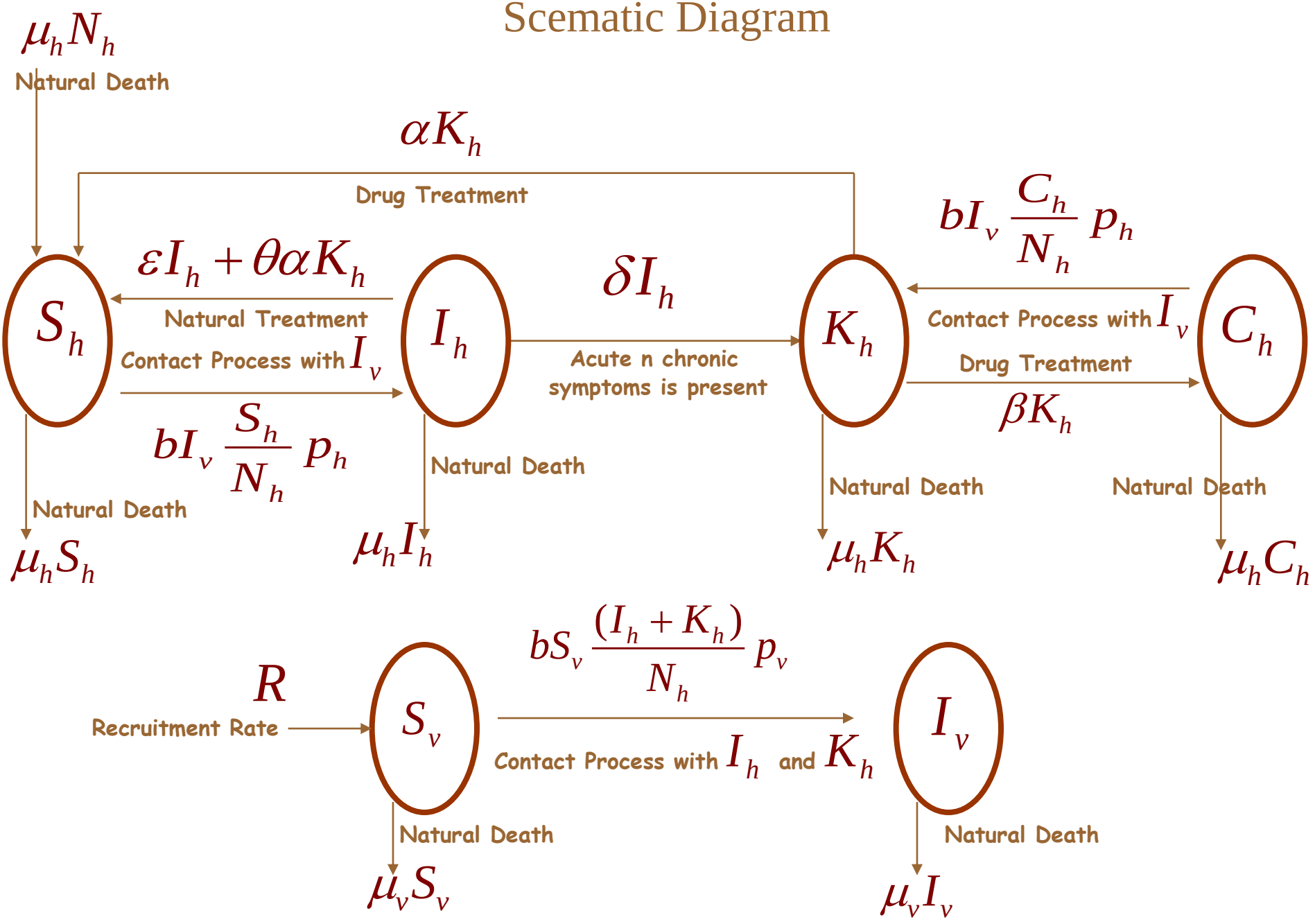
b = Biting rate vector per individual per time

p_h = Succeed transmission probability from vector to host

p_v = Succeed transmission probability from host to vector

R = Total of recruitment rate vector per individual per time

Scematic Diagram



The Distribution of Lymphatic Filariasis Model

$$\frac{dS_h}{dt} = \mu_h N_h + \alpha K_h + \varepsilon I_h + \gamma K_h - bI_v \frac{S_h}{N_h} p_h - \mu_h S_h$$

$$\frac{dI_h}{dt} = bI_v \frac{S_h}{N_h} p_h - \varepsilon I_h - \delta I_h - \gamma K_h - \mu_h I_h$$

$$\frac{dK_h}{dt} = \delta I_h + bI_v \frac{C_h}{N_h} p_h - \alpha K_h - \beta K_h - \mu_h K_h$$

$$\frac{dC_h}{dt} = \beta K_h - bI_v \frac{C_h}{N_h} p_h - \mu_h C_h$$

The Distribution of Lymphatic Filariasis Model

$$\frac{dS_v}{dt} = R - bS_v \frac{(I_h + K_h)}{N_h} p_v - \mu_v S_v$$

$$\frac{dI_v}{dt} = bS_v \frac{(I_h + K_h)}{N_h} p_v - \mu_v I_v$$

Non Endemic Critical Point

$$I_h = 0, K_h = 0, C_h = 0, T_v = 0$$

Non endemic critical point is stabil if:

$$\frac{b^2 P_h P_v N_v (\varepsilon + \mu_h + \mu_v)}{N_h(4\mu_v\alpha\mu_h + 2\mu_v\delta\alpha + 2\mu_v\varepsilon\alpha + 4\mu_v\beta\mu_h + 4\mu_v\mu_h^2 + 4\mu_v\mu_h\varepsilon + 4\mu_v\mu_h\delta + 2\mu_v\beta\delta + 2\mu\varepsilon\beta_v + \alpha^2\mu_h + \beta^2\mu_h + \mu_v\alpha^2 + \mu_v^2\alpha + \mu_v\beta^2 + \mu_v^2\beta + 2\mu_v^2\mu_h + \mu_v\varepsilon^2 + \mu_v^2\varepsilon + \varepsilon\alpha^2 + \varepsilon^2\alpha + \varepsilon\beta^2 + \varepsilon^2\beta + \varepsilon^2\mu_h + \mu_h\delta^2 + 3\mu_h^2\alpha + 3\varepsilon\mu_h^2 + 3\mu_h^2\beta + 3\delta\mu_h^2 + \mu_v\delta^2 + \gamma\delta^2 + \delta^2\alpha + \beta^2\delta + \delta\alpha^2 + \mu_v^2\delta + 2\mu_v\delta\varepsilon + 2\delta\alpha\beta + 2\delta\alpha\varepsilon + 2\beta\delta\varepsilon + 2\alpha\mu_h\beta + 2\alpha\mu_v\beta + 2\varepsilon\alpha\beta + 2\varepsilon\mu_h\delta + 4\varepsilon\alpha\mu_h + 4\varepsilon\mu_h\beta + 4\alpha\mu_h\delta + 4\mu_h\beta\delta + \gamma\delta\beta + \gamma\delta\alpha + \gamma\delta + 2\gamma\mu_h\delta + \beta\delta^2 + 2N_h\mu_h^3)} < 1$$

Endemic Critical Point

$$I_h = \frac{-bI_v p_h(-N_h{}^2\alpha - N_h{}^2\beta - N_h{}^2\mu_h + bI_v C_h p_h + C_h N_h\alpha + \gamma C_h N_h + C_h N_h\mu_h + C_h N_h\beta)}{\left(N_h\left(\begin{array}{l} bI_v p_h\alpha + bI_v p_h\beta + bI_v p_h\delta + \varepsilon N_h\alpha + \varepsilon N_h\beta + \varepsilon N_h\mu_h + \delta N_h\alpha + \delta N_h\beta + \delta N_h\mu_h + \delta N_h\gamma \\ + bI_v p_h\mu_h + \mu_h N_h\alpha + \mu_h N_h\beta + \mu_h{}^2 N_h \end{array}\right)\right)}$$

$$K_h = \frac{(\delta N_h{}^2 + bI_v C_h P_h + C_h\varepsilon N_h + C_h N_h\mu_h)bI_v P_h}{\left(N_h\left(\begin{array}{l} bI_v p_h\alpha + bI_v p_h\beta + bI_v p_h\delta + \varepsilon N_h\alpha + \varepsilon N_h\beta + \varepsilon N_h\mu_h + \delta N_h\alpha + \delta N_h\beta + \\ \delta N_h\mu_h + \gamma\delta N_h + bI_v p_h\mu_h + \mu_h N_h\alpha + \mu_h N_h\beta + \mu_h{}^2 N_h \end{array}\right)\right)}$$

$$C_h = \frac{bI_v p_h \beta \delta N_h^{\,2}}{\left(\begin{array}{l} bI_v p_h \beta \delta \alpha + N_h^{\,2} \mu_h \varepsilon \alpha + N_h^{\,2} \mu_h \delta \alpha + b^2 I_v^{\,2} p_h^{\,2} \alpha + N_h^{\,2} \mu_h^{\,2} \alpha + 2bI_v p_h N_h \alpha \mu_h \\ + bI_v p_h \varepsilon N_h \alpha + N_h^{\,2} \mu_h^{\,3} + 2bI_v p_h N_h \mu_h^{\,2} + b^2 I_v^{\,2} p_h^{\,2} \mu_h + b^2 I_v^{\,2} p_h^{\,2} \delta + N_h^{\,2} \mu_h \gamma \delta + N_h^{\,2} \mu_h \varepsilon \beta \\ + N_h^{\,2} \mu_h^{\,2} \beta + N_h^{\,2} \mu_h^{\,2} \delta + bI_v p_h \gamma N_h \delta + bI_v p_h \varepsilon N_h \mu_h + bI_v p_h N_h \delta \beta + 2bI_v p_h N_h \delta \mu_h + \\ N_h^{\,2} \mu_h \delta \beta + bI_v p_h N_h \beta \mu_h + N_h^{\,2} \mu_h^{\,2} \varepsilon \end{array} \right)}$$

I_v is positif root of equation ;

$$b^2 p_h^{\,2} (\mu_h + \delta + \alpha)(\mu_v + bp_v) I_v^{\,2} - bp_h (-\mu_v \mu_h N_h \beta - \alpha \mu_v \varepsilon N_h - 2\alpha \mu_v \mu_h N_h - \mu_v \delta N_h \beta$$

$$-b\alpha p_h \mu_h N_h - \alpha \mu_v \delta N_h - \mu_v \varepsilon N_h \mu_h + b^2 p_h p_v N_v \delta + b^2 p_h p_v N_v \mu_h - 2\mu_v \mu_h^{\,2} N_h + b^2 p_h p_v N_v \alpha -$$

$$bp_v N_h \mu_h \delta - \mu_v \gamma N_h \delta - bp_v \mu_h^{\,2} N_h - bp_v \beta \mu_h N_h - 2\mu_v \delta \mu_h N_h) I_v + \mu_v N_h^{\,2} \mu_h^{\,2} \varepsilon + \mu_v N_h^{\,2} \mu_h^{\,2} \beta +$$

$$\mu_v N_h^{\,2} \mu_h^{\,2} \delta - b^2 p_h p_v N_v \mu_h^{\,2} N_h - b^2 p_h p_v N_v \beta \mu_h N_h + \alpha \mu_v N_h^{\,2} \mu_h^{\,2} + \alpha \mu_v \varepsilon N_h^{\,2} \mu_h + \alpha \mu_v \delta N_h^{\,2} \mu_h +$$

$$\mu_v \gamma N_h^{\,2} \delta \mu_h - b^2 p_h p_v N_v \delta \mu_h N_h + \mu_v \varepsilon N_h^{\,2} \mu_h \beta + \mu_v N_h^{\,2} \mu_h \beta \delta + \mu_v N_h^{\,2} \mu_h^{\,3} - b^2 \alpha p_h p_v N_v \mu_h N_h$$

Titik Eksistensi Endemi

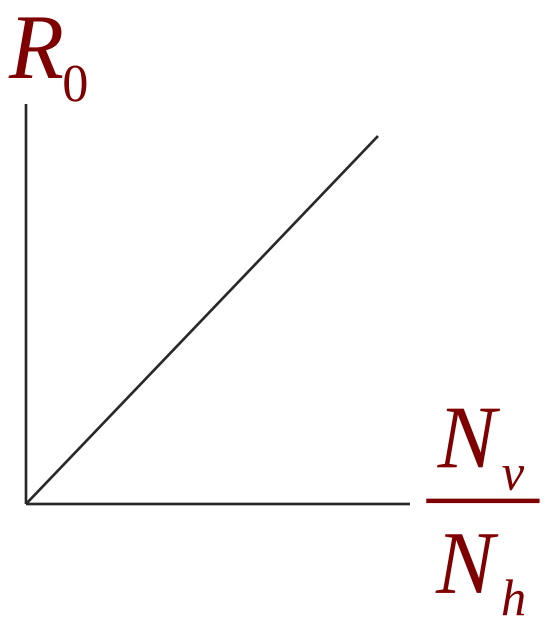
$$\frac{b^2 p_h p_v N_v (\alpha + \beta + \delta + \mu_h)}{\mu_v N_h \left(\mu_h^{\ 2} + \mu_h \beta + \alpha \mu_h + \delta \mu_h + \varepsilon \mu_h + \varepsilon \alpha + \alpha \delta + \varepsilon \beta + \beta \delta + \gamma \delta \right)} > 1$$

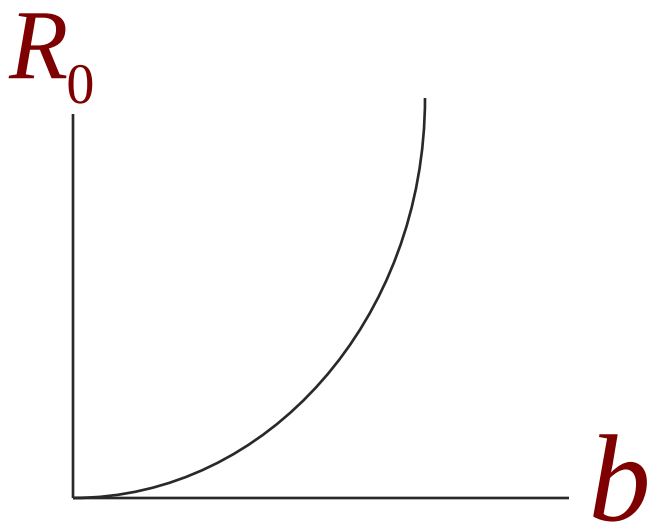
and

$$N_h^{\ 2} (\alpha + \beta + \mu_h) > C_h (b I_v p_h + N_h \alpha + N_h \gamma + N_h \mu_h + N_h \beta)$$

Basic Reproduction Number

$$R_0 = \frac{b^2 p_v p_h N_v}{N_h \mu_v (\varepsilon + \delta + \gamma + \mu_h)}$$





Validation, Interpretation and Model benefit

Basic reproduction number (Ro) explained that filariasis and endemic filariasis is define of:

1. Biting rate of mosquitos
2. The number of mosquitos
3. Blood test of the infected filariasis in their environment

So the simple step for decreasing the spread of filariasis are :

1. Decreasing the bite of mosquitos with used of curtain or mosquitos medicine
2. Decreasing the number of mosquitos population with spray and banish mosquitos
3. Doing the blood test

This model still simple because:

1. Still not involve bionomic vector, which consist of place of birth, bite behaviour and place for rest ,where that factor is benefit for cure the filariasis
2. This Model not involve the mobilitas of the people where the factor of migration is one of the important factor of filariasis spread