Malaria: moving on from the 1950s?

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Malaria Eradication

Vision or Strategy?
Definitions

• **Eradication**
  - Permanent reduction to zero of the worldwide incidence of infection, as a result of time-bound, deliberate efforts. Intervention measures are no longer needed once eradication has been achieved.

• **Elimination**
  - Reduction to zero of the incidence of infection in a defined geographical area as a result of deliberate efforts. Continued measures to prevent re-establishment of transmission are required.

• **Control**
  - Reduction of disease incidence, prevalence, morbidity or mortality to a locally acceptable level as a result of deliberate efforts.
Why is malaria different from smallpox or polio?

- No single magic bullet
- Case detection
- Dependence on vectors and their ecology
- $R_0$ and heterogeneity
Case detection

- **Prompt diagnosis of outbreaks is essential for any program for elimination of a pathogen**
- Smallpox, polio, measles
  - Clinical diagnosis is specific
  - Minimal local infrastructure needed for diagnosis
  - Feasible to pick up sporadic cases in remote areas and “mop-up” with vaccine
- Malaria
  - Clinical cases confused with respiratory infections, meningitis, sepsis.
  - Diagnosis needs microscopy or RDTs
  - Elimination can only be confirmed by diagnosing large numbers of suspected cases (most will be negative)
- **Repair or construct a well-functioning health system before you even think about it.**
Dependence on vectors and their ecology

• As a vector-borne disease, malaria is extremely sensitive to environmental changes
• In general, urbanisation/modernisation reduces human-vector contact
• This greatly facilitated elimination in industrialised countries
• Encourages optimism about other places
100 infectious bites/person-year

Village with malaria

Average exposure 10 infectious bites/person-year

Village without malaria

Village without malaria

Village without malaria

Village without malaria

Village without malaria

Village without malaria

Village without malaria

Village without malaria

Figure modified from Paul Libiszowski
Heterogeneity

- heterogeneity makes it easier to eliminate a pathogen if you can target interventions
- heterogeneity makes it harder to eliminate a pathogen if you can’t target
- With malaria, targeting is relatively difficult because of the difficulty of diagnosis
Heterogeneity

- Acquired immunity to typical viral pathogens is long-term and prevents reinfection.
- In small populations, the reservoir of susceptibles is rapidly “used up”.
- Such viruses therefore need a minimum size of host population to persist.
- Acquired immunity to malaria controls disease but does not prevent reinfection.
- Everyone remains susceptible to reinfection.
- **There is therefore no theoretical minimum host population for the persistence of P. falciparum.**
- **P. falciparum** can persist undetected in small pockets.
The geographical distribution of malaria infections

>80% of deaths

Elimination would be realistic in many localities with major global efforts

Pampana & Russel, 1955; World Health Organization, 1966; WHO, 1997; Hay et al., 2004
In some places it makes good sense to focus on elimination now.

Pampana & Russel, 1955; World Health Organization, 1966; WHO, 1997; Hay et al., 2004
The geographical priority for global malaria control

>80% of deaths

Pampana & Russel, 1955; World Health Organization, 1966; WHO, 1997; Hay et al., 2004