Early Detection of Malaria in an Endemic Area: Model Development

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### Malaria epidemics during 1980-1999

<table>
<thead>
<tr>
<th>Year Range</th>
<th>Description</th>
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<tbody>
<tr>
<td>1980-1984</td>
<td>Epidemic in provinces along the Thai-Cambodia border namely Surin, Srisaket, Buriram, Prachinburi, Chantaburi and Trat Provinces (\textit{P. f} epidemic).</td>
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<td>1998</td>
<td>Epidemic in Southern part namely Surat Thani, Yala, Nakhon Sri Thammarat, Krabi Provinces (\textit{P. v and P. f} epidemics).</td>
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</table>
Background

The existing epidemic warning system was based on the Normal distribution using graphs displaying the monthly mean of 5-year back data on number of reported cases and Mean+2SD. The observed data were plotted if the cases were more than Mean+2SD.

This system is fully accepted by the local staffs but it was low sensitivity and being dependent on alertness of the staff to take further action on analyzing the data and applying the appropriate control measures. This method may not be timely for detecting the occurrence of malaria epidemic which usually occur within a short period of time.
The Poisson distribution was considered as an alternative method for developing an early detection model. The malaria data represented the counting number of events over a period of time. The occurrences of malaria epidemics were common events but did not happen that often.

Malaria data fit the assumptions of the Poisson distribution well enough to generate an early detection system for malaria epidemics, and provide a better fit for monitoring the malaria situation within a limited time period.
The concept of an integrated monitoring system (Delecollete, 1998)
The concept of an integrated monitoring system including the forecasting, early warning and early detection system (Delecollete, 1998).

An early detection system is based on malaria data recorded on a monthly or weekly basis within the health care facilities which are supposed to diagnose malaria and deliver treatment.
The concept of an integrated monitoring system including the forecasting, early warning and early detection system (Delecollete, 1998).

Early warning system based on meteorological data which can predict an epidemic from 1 to 2 months in advance allowing health district staff to be better prepared to detect and control the epidemic at its earliest stage.
The concept of an integrated monitoring system including the forecasting, early warning and early detection system (Delecollete, 1998).

Long range forecasting data are expected to provide health authorities with warning at national or regional scale with longer time lag (from 2 to 6 months) than meteorological data.
The concept of an integrated monitoring system including the forecasting, early warning and early detection system (Delecollete, 1998).

An early detection system is based on malaria data recorded on a monthly or weekly basis within the health care facilities which are supposed to diagnose malaria and deliver treatment.
Early detection indicators

- All malaria cases are microscopically confirmed from Health facilities.
- The onset of an epidemic situation used to confirmed 1-2 weeks in advance.
- Due to epidemic is already in process and it is detected before it is going to rise, this system offers short lead times for prevention and control.
- High specificity
- It is applicable for detection of malaria epidemic at sub-district level
Objective

To develop an early detection system for monitoring of malaria epidemics in Thailand.
Methodology

- Model specification
- Model validation
- Model testing
- System development
Model Specification

Step 1

- Kanchanaburi and Trat were selected to perform the model specification and model validation.

- The weekly malaria cases reported were collected in fiscal year 2000 and 2001 using the data extraction form.

- The data collection divided a period of time into 52 weeks per year
Map showing 30 border provinces of Thailand along International Borders

Total number malaria clinics 535

- Thai/Myanmar (10 Prov.) 128 (24% of total)
- Thai/Laos (10 Prov.) 106 (20% of total)
- Thai/Cambodia (6 Prov.) 76 (14.2% of total)
- Thai/Malaysia (4 Prov.) 30 (5.6% of total)

Total border MC. = 340 (63.6% of total)
Model Specification

Step 2

- The numbers of cases in 2000-2001 were calculated as the point estimation (Mean) of each week.

- The weekly mean was calculated for the interval estimation (the lower and upper limit) with 95% confidence interval.

- The calculation of interval estimation based on the assumption of the Poisson distribution using STATA.
How to calculate the Epidemic Threshold

<table>
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<tr>
<th>Week</th>
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<td>Case 2000</td>
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<td>X2</td>
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<td>Mean</td>
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<tr>
<td>Calculate upper Limit with 95% CI based on Poisson Distribution using STATA</td>
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Model Specification

The Poisson equation is shown as below.

\[ P(N = k) = \frac{e^{-\lambda} \lambda^k}{k!} \]
Model Specification

Step 3

- The line graphs of weekly mean, lower and upper limit with 95% confidence interval from the Poisson distribution were plotted as the early detection model in Kanchanaburi and Trat.

- The upper limit was considered as the Epidemic Threshold or critical point of detection.
Epidemic thresholds

- Upper limit of malaria cases based on Assumption of *Poisson* distribution
  - compute the weekly mean value and the upper limit of weekly data, if weekly cases exceeds the upper limit, declared as epidemic weeks.
The Poisson distribution of weekly mean of malaria cases Kanchanaburi Province, FY2000-2001.
Interpretation

- The area between the weekly mean and the upper limit of the *Poisson* distribution was considered as the detection area of the model.

- If weekly cases exceed the threshold (upper limit), declared as epidemic weeks. The trend of malaria case is higher than the acceptable level or closed to peak of epidemic in the next week.
Model validation

STEP 1
- The time series analysis of monthly malaria cases during 1991-2001 in Kanchanaburi and Trat were analyzed to investigate the distribution of malaria cases during the past 11 years.
  - These findings revealed that the monthly malaria cases distribution of Kanchanaburi in 1999 and 1997 were the years with highest and lowest malaria cases, respectively.

STEP 2
- The monthly malaria cases of these two years were plotted on the monthly Poisson distribution for validating the model.

Assumption: The year with the highest malaria cases should be higher than upper limit.
The Poisson distribution of monthly mean of malaria cases in Kanchanaburi Province, 1991-2001

Early detection point
CONCLUSION
Malaria situation along the Thai borders was still a serious public health problem, especially in Thai-Myanmar and Thai-Cambodia border areas.

The Poisson distribution was considered to be an alternative method for the development of early detection model that gave the satisfactory model specification and validation.

The early detection model based on the routinely epidemiological data collected that could detect the increasing number of cases earlier one or two weeks before it reached to the highest peak of transmission.
The early detection system development and testing gave the satisfactory results for the monitoring of weekly malaria situation in VBDU level (Sub-District Level).

The application of early detection system was essential for malaria officers that was implemented into malaria epidemiological works and could be considerably helpful to the decision making process, planning and budget allocation for The Thai Malaria Control Programme.
Model Applications

The early detection system was useful for monitoring of malaria epidemics especially, in highly endemic provinces along the Thai borders.

The validity and completeness of the secondary data were very crucial for the development of early detection model.

The implementation of early detection system need to be done at the VBDU level and required:

- Computer and network system (on line)
- Training
Limitations

- Epidemic thresholds have to be established according to local epidemiological settings.
- Requires surveillance system, laboratory procedures, data analysis, timely reporting and notification.
The application was developed based on the concept of *Poisson* distribution and called as the **MALED†S model**. (MA†aria Early Detection System)
Website

Bureau of Vector Borne Disease
• http://www.thaivbd.org

Malaria Early Detection System
ระบบเตือนภัยทางระบบวิทยาการใช้มาลาเรีย

MALARIA EARLY DETECTION SYSTEM PROJECT

วันที่ 24 กุมภาพันธ์ 2549 18:36:56

กรุณากรอกชื่อผู้ใช้และรหัสผ่านผู้ใช้

ชื่อผู้ใช้: admin
รหัสผ่านผู้ใช้: ********

ชื่อที่ใช้: ที่อยู่อีเมล: admin@domain.com

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