Prospect of Geo-mapping application in Vector-borne diseases control

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Introduction
Health care system in Vietnam

Ministry of Health
- General Department of Preventive Medicine (GDPM)
- Treatment Department
  - Regional Institute
    - Pasteur HCMC: South (20 provinces)
    - Pasteur Nha Trang: Central (11)
    - TIHE: Highland (4)
    - NIHE: North (28)
  - Regional hospitals
  - General hospitals of provinces/cities
- CDC
- District Health Center
- Commune Health Stations
- Feedback Report

Provincial People’s Committee
- Provincial Health Service
- District Health Bureau

Map of Vietnam
Dengue situation
The South in compare to VN
- 75% Dengue cases
- >90% Dengue deaths
- 96% Zika confirmed cases
- 100% CHIK confirmed cases
Distribution of dengue cases by weeks

Số ca

Tuần

2018

2019

2020

2021

2022

Mắc 2018

Mắc 2019

Mắc 2020

Mắc 2021

Mắc 2022
Distribution of dengue cases by provinces
Surveillance system
Principles

Medical settings

Field
Current dengue surveillance system

As a passive surveillance system enhanced by laboratory, including:

- Epidemiology surveillance
  - Daily/weekly/monthly report of inpatient clinical case
  - Line listing of cases

- Laboratory surveillance
  - 7% of clinical dengue case for MAC-ELISA
  - 3% of clinical dengue case for virus isolation
  - Randomly collected in all hospitals

- Entomology surveillance: monthly survey
  - 1 sentinel point of each district
In order to determine Dengue pattern

- Implementing all of 3 types of dengue surveillance in 1 site
- Sentinel site: 1 district / province
- Case and virology surveillance for all dengue cases in district hospital
  - Collect epidemiological and clinical information
  - Collect blood for testing: NS1 (\(\leq 5\) days of illness), ME (> 5 days)
  - Feedback NS1 testing result within 30 minutes for case management and outbreak control

- Monthly entomology survey in representative site
In hospital

Out-patient

In-patient

Update

Follow up

eCDS

CRF

eCDS

Follow up

Additional detection

CRF
In hospitals

Regional hsp
Provincial hsp
District Health Centers
Commune Health Stations
Private hsp/clinics

GDPM
Pasteur
Local Health Service
CDCs
District Health Centers
Commune Health Stations
In the field

Detect from eCDS

Confirm on eCDS

Self-report

Trace back

Update on eCDS
Data management and report
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Mapping application
Mapping application

Levels of dengue response

Continuously prevention

Small outbreak intervention

Source reduction campaign

Epidemic intervention

Outbreak intervention

1 death

1 severe dengue case

At least 2 dengue/village/7 days

1 lab confirmed dengue
Mapping application

JOHN SNOW
Doctor

He shares the name with a famous TV character but should be famous for other reasons. He was the one who mapped the Cholera outbreak in London in 1854. His finding led to a public health overhaul around the world.
Mapping application

The effects of climate change are widespread and rapidly intensifying and are largely driven by greenhouse-gas emissions from burning fossil fuels. Global mean temperatures have already increased by 1.1°C since 1900, with most of the change having occurred in the past 50 years. The extent of change is most extreme in highland and polar regions (Fig. 1), and temperatures in tropical regions are creeping closer to the thermal limits of many organisms. Given the current policies and actions, a warming of 2.5°C to 2.9°C or more by the end of this century is expected. Warming and other manifestations of climate change include changes in precipitation, with increased flooding in some areas and droughts in others — having important implications for vector-borne diseases through their effects on pathogens, vectors, and hosts, as well as on our ability to prevent and treat these diseases (Fig. 2). Yet attributing changes in the distribution and frequency of vectors and diseases to climate change is challenging because other factors, including climate-sensitive vector-borne diseases, also have a role. The primary reservoir host — by infected female mosquitoes, most commonly Aedes aegypti and A. albopictus. Water-storage containers, which are commonly used in regions where a piped water supply is inadequate, or rainwater-filled containers (e.g., tires, pots, and tree holes) can become mosquito breeding sites and can thus drive epidemics. Transovarial transmission of dengue virus (from female mosquitoes to their offspring) and the long-distance dispersal of drought-resistant aedes eggs in suitable containers facilitate efficient expansion of the virus worldwide. The northward expansion of A. aegypti and A. albopictus thus far is best explained by human movement patterns within regions in which the climatic conditions are suitable for geographic expansion; however, by 2030, the dominant vector of dengue virus is expected...
Mapping application

- Case position
- Outbreak identification
- Disease dynamics
- Prediction
Mapping application

- Suitable for case intervention
- Could not be described by:
  - Spatial-temporal dynamics
  - Risk factors
- Un-suitalbe for indicating large scale intervention
Mapping application

Inputs

- Monthly Dengue data
- Monthly meteorological forecast data

Black box

- 56 ensembles

Outputs

- Probabilities of exceeding epidemic threshold by provinces and 6 month in advance
Mapping application
Mapping application

Probabilistic seasonal dengue forecasting in Vietnam: A modelling study using superensembles

Felipe J. Castro-González, Leonardo Scors Sasiboom, Barbara Holmstock, Alison Ippolito, Selvam Marimuthu, Tim Craighead, Sarah Asian, Brandon Fairman, Francesco Marchetti, Graham Banerjee, Erika Baker, Thomas W. Casual, Mark Harrison, Danie Teunis, David Lundeberg, Oliver J. Brady, Martin Lowery

Abstract

With enough and accurate reports, dengue outbreaks can be mitigated. As a climate-sensitive disease, environmental conditions and past patterns of dengue can be used to make predictions about future outbreak risk. These predictions improve public health planning and decision-making to ultimately reduce the burden of disease. Past approaches to dengue forecasting from using seasonal climate forecasts, but the predictive ability of a system will vary depending on the disease vector characteristics.

Methods and findings

We introduce an operational seasonal dengue forecasting system for Vietnam where Earth observations, seasonal climate forecasts, and logged dengue cases are used to drive a suite of time horizons and transmission settings. Using historical data, the superensemble made slightly more accurate predictions (continuous rank probability score [CRPS] = 68.8, 95% CI 60.6–118.0) than a baseline model which forecasts the same incidence rate every month (CRPS = 79.4, 95% CI 78.5–80.5) at lead times of 1 to 3 months, albeit with larger uncertainty. The outbreak detection capability of the superensemble was considerably larger (68%) than that of the baseline model (54.5%). Predictions were most accurate in southern Vietnam, an area that experiences semi-regular seasonal dengue transmission. The system also demonstrated added value across multiple areas compared to previous practice of not using a forecast. We use the system to make a prospective prediction for dengue incidence in Vietnam for the period May to October 2020. Prospective predictions made with the superensemble were slightly more accurate (CRPS = 110, 95% CI 102–573) than those made with the baseline model (CRPS = 125, 95% CI 120–168) but had larger uncertainty. Finally, we propose a framework for the evaluation of probabilistic predictions.
Mapping application

- Limitations
  - Using weather forecast to predict
  - Hydrological and meteorological data are not included in surveillance system
  - Need to refer other information to determine where to conduct intervention
  - Depend on staff abilities and experience
Mapping application
Conclusion
Conclusion

- Dengue is great concerns and difficult to control
- Mapping is a strong application for Dengue control
- Flexible and well organized surveillance system

Current data
- Detailed and could be positioned
- Adequate for disease dynamic, mapping studies and forecasting tool development

Challenges:
- Innovative approach
- Resources
- Sustainability
Thank you