MERIT:
Climate information for the prevention and control of meningococcal meningitis in the Sahel: a multidisciplinary partnership

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Epidemic Meningitis in Africa: the problem

Meningococal Meningitis, bacterial form of meningitis
Direct transmission, person to person, respiratory droplets
12 serogroups. 4 in Africa: A, C, W135, X
Serious infection of the thin lining that surrounds the brain and spinal cord
Belt stretches from Senegal in the west to Ethiopia in the east (80% of the global burden)
430 million people at risk, 1 million cases since 1998
10-50% fatality rates, 10-20% of survivors suffer permanent brain damage
Meningococcal Meningitis A Prevention and Control strategies

Old

Reactive - polysaccharide vaccine – used in response to epidemic (A, C, X etc.)

New

Proactive – Conjugate vaccine – used to prevent epidemics of Meningococcal Meningitis A.
Control: reactive vaccination

- District level
- Based on incidence thresholds (enhanced weekly surveillance)
- Does not prevent all cases

**CHALLENGE:**

- Timely vaccination to optimize the control of the epidemics

![Graph showing cases per 100,000 population per week from wk1 to wk20. The graph illustrates an epidemic threshold at 10 cases per 100,000 population and an alert threshold at 5 cases per 100,000 population. The epidemic peaks between wk8 and wk15.]
Proposed MenA conjugate vaccine introduction

Need for improved risk assessment for next 10 years
Decision makers concerns

Response to outbreaks

- Reducing time between outbreaks onset and reactive vaccination
- Setting criteria for ending response to outbreaks
- Forecasting: vaccine production and procurement

Introduction of a new conjugate vaccine

- Coverage scaling up: where first?
- Is the belt changing?
- Protection effectiveness over time?
- Coverage level required to prevent outbreaks?
- Risk assessment of non A meningitis outbreaks? (Alert and Attack rates)
How can climate/environmental information inform epidemic meningitis prevention and control?

- improve understanding of the *mechanisms* of climate impact on transmission and disease
- estimate populations at risk (*risk mapping*)
- estimate *seasonality* of disease and timing of interventions
- monitor and predict *year-to-year variations* in incidence (including early warning systems)
- monitor and predict *longer term trends* (climate change assessments)
- improve *assessment of the impact of interventions* (by removing climate as a confounder)
Creation of the MERIT Initiative

- Established in 2007 at a GEO hosted meeting in Geneva
- Collaborative initiative of WHO and members of the environmental, public health and epidemiological communities to help reduce the burden of epidemic meningitis in Africa
- Research projects, modeling developments and collaborative partnerships progressing within the MERIT framework
- To inform and support the reactive and preventative vaccination strategies by combining knowledge, research and expertise of about 30 international and regional partners
Meningococcal Meningitis: an environmental disease

At the time MERIT was formed climatic and environmental factors were understood to affect:

- Geographic occurrence of severe epidemics (the meningitis belt – confined to the semi-arid Sahel)
- Seasonality of disease (confined to the hot, dry and dusty dry season)
- Also - Widespread acceptance of the importance of immunity, bacterial strains and population characteristics (including density)
- Tantalizing hints that climate variability might be important in the timing and intensity of disease occurrence – but research lacked quality climate, environmental and epidemiological data and robust analysis.
- Speculations on the mechanism(s) by which climate/environmental factors impact on meningococcal meningitis transmission and conversion from carriage to invasive disease – but little concrete evidence.
MERIT seeks to inform...

three operational areas:

- the reactive vaccination strategy (improve the impact of the reactive mass vaccination campaigns, prepare for the following epidemic season, refine the response strategy for outbreaks due to serogroups other than A, assess the risk of NmA outbreak in areas previously vaccinated with the conjugate A vaccine);

- the preventive vaccination campaigns with the conjugate A vaccine (guide the introduction of the conjugate A vaccine and estimate the impact of the conjugate A vaccine); and

- 5 to 10 years time-horizon forecasting to gather information on the possible vaccine needs in the medium and long term.

Key to the MERIT concept was that research needs would be demand led, i.e. identified by those that were responsible for solving the health problem.
The changing landscape of MERIT

2007
- Creation of MERIT at a GEO-hosted meeting in Geneva
- Collaboration between health, environmental and research communities

2008
- 2nd technical MERIT meeting and Ethiopia national workshop, Addis Ababa
- How to make operational use of research for reactive strategy?
- MERIT-Ethiopia case study development

2009
- 3rd technical MERIT meeting and Niger national workshop, Niamey
- Niger case study - development of a decision-tree for testing in the next epidemic season
- Collaboration between partners and various modelling approaches, New York
.. 2010, 2011 and beyond

2010

- Near real-time monitoring of the 2010 epidemic season from January - April
- MERIT modeling workshop, May 2010 New York
- Prequalification of the new conjugate Men A vaccine, June 2010
- 4th Technical MERIT meeting an national workshop, Ethiopia
- MenAfriCar Carriage studies precede Conjugate A vaccine
- Introduction of Conjugate A vaccine in 3 countries

2011

- Integrate and align modelling and research activities to meet specific public health needs
- Finalise MERIT modelling work in case study countries
- 5th Technical MERIT meeting – Geneva – External Review
- Re-orientate MERIT to serve new policy environment

2012

- Build activities according to New MERIT strategy
MERIT Challenges

- Quality and homogeneity of epidemiological data
- Availability, quality and analysis of in-situ meteorological and dust data
- Quality of low resolution atmospheric reanalysis data (2.5x2.5 deg)
- Limitations of satellite sensors and general lack of data and understanding.
- Climate not analyzed in conjunction with other factors (e.g. susceptibility/ Immunity)
- Lack of knowledge on mechanisms or other factors
- Factors changing over time: e.g. circulating serogroups, climate, vaccination type
- Expansion of the Belt and introduction of conjugate vaccine
Focus on 5 variables

- Inter-Tropical Discontinuity (ITD)
- Absolute Humidity
- Dust
- Rainfall (and drought)
- Temperature
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Examples - Dust

MARCH 8, 2006
Courtesy EUMETSAT
Example - Dust

Synthesis of linear correlation analysis of daily data from different sources for 16 AERONET locations

- non-significant correlation
- significant correlation (p=0.1)
- significant correlation medium

Pairs of time series

Linear correlation coefficient

AERONET vs MISR
AERONET vs OMI
AERONET vs RCM
MISR vs OMI
MISR vs RCM
OMI vs RCM
RCM vs GCM

GCM
Example - predicting annual attack rates in Nigeria

**NATIONAL SCALE**

Log (incidence JAN-MARCH) ~ Log (early season Climate)

\[ R^2 = 0.35, \text{ RMSE} = 0.77, \]
\[ \text{CV R}^2 = 0.2, \text{ CV RMSE} = 0.87 \]

Log (incidence JAN-MARCH) ~ Log (early season Climate) & Log (incidence DEC)

\[ R^2 = 0.64, \text{ RMSE} = 0.53, \]
\[ \text{CV R}^2 = 0.47, \text{ CV RMSE} = 0.65 \]

**DISTRICT SCALE**

Log (incidence JAN-MARCH) ~ Humidity (DEC)

Log (incidence JAN-MARCH) ~ Min Surface Temperature (FEB)
In summary – achievements to date

❖ **Health- Climate alliance:** WHO initiative, established at a GEO hosted meeting in 2007 in Geneva:

❖ **Scientific platform**
  - 4 International technical meetings.
  - Operational research: monitoring in near real-time environmental conditions and epidemics, modelling and forecast testing
  - Research subgroups.
  - Country and regional settings
  - Global partnerships

❖ **Information and knowledge dissemination; database development**

❖ **Training**
MERIT community of partners

World Health Organization (Chair)
World Meteorological Organization
Group on Earth Observations
AEMET, Agencia Estatal de Meteorologia, Spain
Climate and Health Working Group, Ethiopia
Health and Climate Foundation
International Federation of the Red Cross and Red Crescent Societies
International Research Institute for Climate Society, Columbia University
Meningitis Vaccine Project

ACMAD
Agence Medecine Preventive
Anti Malaria Association, Ethiopia
CERMES
CIESIN
Google.org
Institut Pasteur
London School of Hygiene and Tropical Medicine
Liverpool School of Tropical Medicine
Mailman School of Public Health, Columbia University

National Meteorological Service
NHRC, Ghana
NIH
Penn State University
Sanofi
UCAR
UNICEF
University of Lancaster
University of Niamey
University of Paris

and others…