From data to decision-making – and back again

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Objectives

• Provide an overview of basic concepts that connect data to decision-making
• Explore how this understanding can help create evidence for policy and practice
• Learn how these perspectives have been developed in the context of disease prevention and control.
Data
even when it's raining data...

...there is an information drought
Data

- The word data is the plural of Latin datum, past participle of dare, "to give", hence "something given". Thus in general, data consists of propositions that reflect reality.

- A large class of propositions are *measurements* or observations of a variable. Such propositions may comprise numbers, words, or images.
Data requirements

• To inform decision-making data must be (at the level specific to the decision):

• Accurate; Timely; Current; Relevant; Complete; Interpretable; Consistent representation; Accessible; Traceable; Easy to use....
Information

• Information is the result of processing, manipulating and organizing data in a way that adds to the knowledge of the user. *It includes the context in which data is taken.*

• The word information can refer to both "facts" in themselves and the transmission of the “facts” (e.g. information system).
Assumption

“better use of information can improve decision making”

While there is research evidence to support this view there is an increasing understanding that there are limitations........

Mainly because decisions are made by people.
So – information alone is not enough
Beyond access: Turning information into knowledge and power

Access to information as part of development strategy is becoming more important, but is information alone enough? Join the debate, Thursday 14 March at 1pm GMT

Anna Scott
Guardian Professional, Tuesday 12 March 2013 07.57 EDT
Jump to comments (245)
Knowledge

• “what is known”. There is no single definition of knowledge on which scholars agree.

• Knowledge acquisition involves complex cognitive processes: perception, learning, communication, association, and reasoning.

• Knowledge is a function not only of truth but also of belief

  Knowledge doesn’t exist until people are involved.
From Data to Decision-making

This requires a systemic process for using data to enhance decision-making, bringing together a vast array of tools to extract value from data and focus efforts on what will add real value to the decision-makers sphere of influence.
Prediction

• Ultimately all decision-making is about the future.

• Therefore if we are to use data to predict climate sensitive health outcomes we need to build models that provides predictive support to health decision-makers to more effectively manage risk and enable change.
Models

• Since models are by necessity a simplified version of the real-world predictions based on models are always uncertain.
• Understanding how uncertain and what factors determine the uncertainty (and whether uncertainty can be reduced) is essential.
• Predictions must necessarily be constantly revised in the light of new experience as the future unfolds.
Laws underpinning predictions

To be able to make predictions it is necessary that we know certain laws:-

- **Exact** – stated in terms of the differential equations of physics and chemistry) – mathematical modeling
- **Statistical** – frequency distributions arising from the very general law of large numbers – statistical modeling
- **Empirical laws** – guided by practical experience and not theory
Climate and infectious disease

<table>
<thead>
<tr>
<th>Diseases</th>
<th>Inter-annual variability</th>
<th>Sensitivity to climate</th>
<th>Climate variables</th>
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<td>Cholera</td>
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<td>Dengue</td>
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Getting Evidence into Policy and Practice
Nutley S, Davies HTO. Making a reality of evidence-based practice: Some lessons from the diffusion of innovations

Four key requirements:

1) agreement as to the nature of evidence

- impact of climate on outcomes
- impact of climate information on outcome
- cost-effectiveness of the use of climate information relative to other interventions
Four key requirements cont’d:

2) a strategic approach to the creation of evidence, together with the development of a cumulative knowledge base.

3) effective dissemination of knowledge; together with development of effective means of access to knowledge.

4) initiatives to increase the uptake of evidence in both policy and practice.
What are our objectives?

i. improve understanding of the mechanisms of climate impact on transmission and disease

ii. estimate populations at risk (risk mapping)

iii. estimate seasonality of disease and timing of interventions

iv. monitor and predict year-to-year variations in incidence (including early warning systems)

v. monitor and predict longer term trends (climate change impacts and vulnerability assessments)

vi. improve assessment of the impact of interventions (by removing climate as a confounder)
Improve understanding of disease transmission mechanisms: Malaria

Figure 1.13. Stock-flow model of the human host component of the mathematical tool proposed by Ruiz et al. (2006)
Figure 1  Thermal performance curves for all mosquito and parasite life-history traits that together determine $R_0$. Note that the temperature ranges (x-axes) differ for different traits. Data sources, parameter descriptions and fit functions are listed in Table 2. The original mortality data are shown in Fig. S2.
Understanding of disease transmission mechanism: Meningitis

Meningococci

Integrity of mucosal membrane lining the nose and throat

Integrity lost through:
• microbial damage from other infection – e.g. flu?
• physical damage from low absolute humidity and dust?

Blood stream

Courtesy Brian Greenwood
Estimate populations at risk (risk mapping)

Kala azar – Sudan

Meningitis Belt

Presence/absence of Phlebotomus orientalis

Presence/absence of recorded meningococcal meningitis epidemics

0.0 - (lower)
0.4 - (medium)
0.6 - (high)
0.8 - (very high)
Prevalence survey data

Criteria which should always be assessed:

• Was the target population specified?
• Which sampling method was employed?
• Is the survey based on a random sample or a whole population?
• Was the sample size adequate?
• Was the response rate adequate?
• Was information given on non-responders?
• Was a valid and repeatable disease definition given?
• Have reasonable efforts been made to reduce observer bias?
Onchocerciasis Control Programme is being extended to the rest of Africa

Drug control has already broken down in some areas where ecological conditions favour the occurrence of *Loa loa*.
Modeling risk of *Loa loa* infection in Cameroon

Point estimates of the prevalence of *Loa loa* microfilaraemia, over-laid with the prevalences observed in field studies.
Modeling risk of *Loa loa* infection in Cameroon

A probability contour map, indicating the probability that the prevalence of *Loa loa* microfilaraemia in each area exceeds 20%, overlaid with the prevalences observed in field studies.

Routine surveillance data

• Data sources:
  – Notifiable disease-specific reporting systems
  – National Health Management Information System
  – Integrated Disease Surveillance and Response System

• Requirements:
  – Consistent reporting units with known populations
  – Clearly defined and useful indicators
  – Reasonable completeness
  – Consistent time periods, preferably at least monthly
Routine surveillance data

Can assist in:

• Monitoring trends
• Clarifying and measuring seasonality
• Prioritizing areas for intervention
• Defining and quantifying epidemics
• Evaluating control measures
Routine surveillance data – use it or lose it?

• The spatial (point, administrative boundary) and temporal (daily, weekly, monthly) structure of health surveillance data along with its national coverage make it theoretically ideal for use in the development of climate and health models.

• However the data is often shunned because of poor quality of records.

• Improvements of the routine surveillance system and a stronger Health Information System are needed.
Indicators and triangulation

Core indicators – population based

– Incidence of total malaria cases (clinical plus confirmed)
  • Because diagnostics not available everywhere at all times
  • Because availability of diagnostics has increased greatly – i.e. total malaria may be more consistent over time

– Incidence of confirmed malaria (RDT or slide) cases, by species
  • Because not all clinically diagnosed malaria is really malaria
  • Different species may have different trends

– Incidence of malaria admissions
  • Measures severe malaria
  • Assesses success of early treatment
Triangulation

If similar trends observed from several indicators and several data sources, we have more confidence that trends are real
Estimate seasonality of disease and timing of interventions

Using NHIS malaria data in Eritirea to map the seasonality and intensity of malaria.
Why is climate data unique?

- The following characteristics of climate make it potentially ideal as an additional layer of information for the health sector for application in malaria vulnerability assessments, surveillance and forecasting:

- its climatology, seasonality, diurnal rhythm and potential predictability at multiple time scales (weather, seasonal, decadal and climate change).
Climate suitability for malaria transmission (CSMT)
Demand for integrated early warning systems ...
Factors which increase vulnerability to malaria epidemics

There are many factors that increase the vulnerability of a population to malaria epidemics and increase the severity of disease outcome should a malaria epidemic occur. Examples include:

- Co-infection with other diseases
- Resistance to therapeutic drugs and insecticides
- Drought, food insecurity and associated population movements between areas of differing endemicity
- Economic losses – reducing household capacity to manage illness
Malaria Early Warning in Botswana

>20 Years good surveillance

Laboratory confirmed

Good coverage as quality service widely used
Case surveillance

Example in Botswana .. Of a number of indicators (WHO 2004) the NMCP uses case thresholds defined for three levels of alert ...

**OKAVANGO SUB-DISTRICT**

**ACTION 1:** When district notification reaches/exceeds 600 unconfirmed cases/week

- **DEPLOY EXTRA MANPOWER AS PER NATIONAL PLAN**
  - Request 4 nurses from ULGS by telephone/fax
  - Collect the 4 nurses from districts directed by ULGS
  - Erect tents where needed
  - Catchment areas to deploy volunteers in hard-to-reach areas
  - Print bi-weekly newsletter to inform community about epidemic

**ACTION 2:** When district notification reaches/exceeds 800 unconfirmed cases/week

- **DEPLOY MOBILE TEAMS PER DISTRICT PLAN**
  - Each team to be up of a Nurse or FEW, a vehicle and a driver
  - Deploy teams as follows:

<table>
<thead>
<tr>
<th>TEAM AND DEPLOYMENT AREA</th>
<th>VEHICLE</th>
<th>Reg No</th>
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<tbody>
<tr>
<td>Team A: Qangwa area</td>
<td>Council</td>
<td></td>
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<tr>
<td>Team B: Habu / Tubu / Nxaunxau area</td>
<td>Council</td>
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<tr>
<td>Team C: Chukumuchu / Tsodilo / Nxaunxau area</td>
<td>Council</td>
<td></td>
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<tr>
<td>Team D: Shakawe clinic (vehicle and driver only)</td>
<td>DHT vehicle</td>
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<tr>
<td>Team E: Gani / Xaudum area</td>
<td>Gani HP vehicle</td>
<td></td>
</tr>
<tr>
<td>Team F: Mogotho / Tobera / Kapatura / Ngarange area</td>
<td>Mogotho HP vehicle</td>
<td></td>
</tr>
<tr>
<td>Team G: Seronga to Gudigwa area</td>
<td>Gudigwa HP vehicle</td>
<td></td>
</tr>
<tr>
<td>Team H: Seronga to Jao Flats</td>
<td>Boat</td>
<td></td>
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</tbody>
</table>

- Deploy MO at Shakawe and 2 more nurses as per National Manpower contingency plan

**ACTION 3:** When district notification reaches/exceeds 3000 unconfirmed cases/week

- **DECLARE DISTRICT DISASTER**

  - Call for more outside help (manpower, vehicles, tents, etc)
  - Convert some mobile stops to static treatment centres
  - Station nurses at the static treatment centres
  - Station GDA to assist nurse eg cooking for patients on observation
  - Erect tents with beds and mattresses (6 – 10 beds/tents) at selected centres
  - Station vehicles at selected centres
  - Deploy MO or FNP at Seronga
  - Station officer from MOH to co-ordinate epidemic control with DHSCC

**Threshold 1** - 600 unconfirmed cases/week >>> Action Plan 1.

**Threshold 2** - 1000 unconfirmed cases/week >>> Action Plan 2.

**Threshold 3** - 3000 unconfirmed cases/week >>> Action Plan 3.
High and low years are defined by the upper and lower quartiles (after detrending and log transformation).
Malaria incidence in Botswana (Feb, Mar, Apr) is strongly related to rainfall variability during the peak rainfall season December – February.
Malaria in Botswana varies from year to year according to the climate and the temperature of the sea in the Nino 3.4 region.
Botswana 1982-2002

5 high malaria anomalies

5 low malaria anomalies
Temperature and Malaria trends in the East African highlands

A - Has malaria increased?

B - Has Temperature increased?

C - If A and B are both positive is are increases in A are related to increases in B?

D - If B is positive is this related to global warming?
A. Has malaria increased in the East African Highlands

Monthly malaria cases at Kericho Unilever Tea Kenya Ltd Hospital.

‘Analyses of malaria time-series at such sites have shown that malaria incidence has increased in the absence of co-varying changes in climate’. Hay et al., (2002).
B. Has Temperature increased in the East African highlands?

Reiter, (2008) “Whatever the cause, the history of multiple epidemics in the earlier part of the century, including many at higher altitudes, makes it unnecessary to infer climate change as a contributory factor. Moreover, a set of well-maintained meteorological records shows no significant change in temperature over recent decades.”
If B is positive is this due to global warming?

**GOING UP**
Malaria incidence and temperatures have risen near Kericho in Kenya over the past 30 years; health experts are keen to know whether they are linked.

Figure 5 – NMA’s improved website, designed by IRI and developed by a local company, is designed in such a way that the user can find information easily. It presents existing and new products from simple station history to more sophisticated maps. It also makes locating and ordering data sets easier. The sector-specific Map Rooms on the right facilitate the use of climate information.
Climate suitability for malaria transmission (CSMT)

Created using interpolated station data (UEA Gridded Data, 0.5 deg lat/lon res)

Created using blended national station data and satellite data (10 km res)
ENACTS (rainfall and Temperature Tanzania)

Climatology Seasonality

Trends
Compare Tanzania CMAP (crude) WASP Analysis for Presidents Malaria Initiative

1997/8 El Nino
Tanzania WASP Analysis for PMI

1997/8 El Nino
The role of the decision-making in making decisions

• We need to investigate the role of the decision maker in making decisions.
• Causal models are not the only requirements for effective prediction - there must also be a willingness to use the information and the models.
• The process from data collection to dissemination should engender decision making
Decisions may vary depending on:

- Availability and perceived reliability of the data
- Certainty of outcomes associated with different options
- Experience / expertise of decision maker
- Decision making environment
- Personality of the decision maker(s).
- The cognitive biases that influence the decisions in a given situation.
- Incentives/Dis-incentives (decision v. Act of God)
Conclusions

• There is research evidence that use of information can improve decision making.
• Much of the research has focused on a rational approach to decision making.
• However people don’t necessarily take a rational approach to making decisions.
• The degree to which data and information reflect fact or truth the greater the potential for informed decision-making.
• We need to understand how individuals make decisions.
Conclusions

To improve decision making through the use of data and information the models established at each point in the process (from the collection of data to the mental model of the decision-maker) should be as closely aligned to the entity about which the decision is being made as possible.
Data, particularly numeric data, are often considered to be fact. In fact this discussion demonstrates that the data at the decision-making state is a product of a number of subjective models. In order for decisions to be improved care must be taken to ensure that there is alignment of the models so that they model at the decision stage is as close as possible to representing the entity about which the decision is being made.
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District level reactive vaccination response to meningitis epidemics