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Editorial

Defining & counting malaria deaths

The recent World Malaria Report[1] suggests that deaths due to malaria in 2009 have decreased compared to 2000. This may be and we, as public health workers, should hope so. However, much of the data are derived from the extrapolation of a few strata of transmission risk into incidence or assume static fatality rates among estimated cases. The good news is that these estimates are supported by other data sources including facility and community based evaluations. But while conjectures on trends are both reasonable and the limit of the possible, we do not, and may never, know how many people are dying from malaria. Without accurate information on malaria mortality (and other deaths) we cannot detect outbreaks, define risk factors for intervention, rationally allocate resources, or determine whether a public health programme is working. Deaths are also a sentinel event and tend to represent the tip of an iceberg, with a large burden of morbidity floating below. Understanding the assumptions made in classifying and counting deaths could improve malaria control.

What is a malaria death?

Malaria deaths are difficult to record. Fatal cases tend to occur among the most marginalized populations and in remote areas far from the public health system. Thus, data from routine reporting are considerably underestimated. First, the idea of cause-specific death attribution is a challenge as those suffering from malaria are liable to suffer from other illnesses, either simultaneously or in rapid sequence. Interactions between diseases are often ignored which can marginalize the burden of debilitating conditions which manifest a chronic course. *Plasmodium vivax*, the so-called benign tertian malaria, is an example of relative public health neglect, compared to *P. falciparum*, as we incorrectly assumed the former rarely precipitated mortality. In most countries malaria deaths, by either species or often only those of *P. falciparum*, are recorded via case definitions that form a spectrum of suspected, probable, and confirmed. The principle criteria for each category include a combination of clinical or parasitogical findings ranging from fever of unknown origin (suspected death - least rigorous) to parasitemia at the time of death in the absence of another obvious cause (confirmed death - most rigorous). Case definitions which necessitate laboratory confirmation can be problematic given a lack of diagnostics or because of pre-treatment with antimalarials. Alternatively, without laboratory confirmed data many non-malaria deaths will be classified as malarial as clinical symptoms alone lack specificity.

The surveillance perspective of a malaria death may end here, but we are yet devoid of any mention of causation. Therefore, "who dies from malaria?" may be a more instructive question. After all, not all malaria cases develop severe complications and not all severe cases prove lethal. What explains these different outcomes? Are variations in the characteristics of the aetiologic agent responsible? Virulence factors such as mutations associated with drug resistance vary between strains. This may explain higher death rates in some regions compared to others. However, within a given community where the same strains are responsible for the disease burden, parasite biology seems incomplete as an explanation. Similarly, host attributes including the assorted haemoglobinopathies reduce the likelihood of severe malaria, but even amongst similar individuals some die and others do not. This leaves what we could term as social and ecological factors. An individual's ability to access education, food, housing, and healthcare therefore, may be the most important direct (exposure to illness and access to all forms of support) and indirect

(personal constitution including nutrition status and immune function) contributors to detrimental outcomes.

Experience bears out the importance of non-biological factors. Social influences can also be difficult to capture using traditional research methods. Poverty, unfortunately declines to reduce itself to a simple covariate in our regression models. In our case-control study of risk factors for mortality among malaria patients in Northeastern India, 'exposure' to illiteracy and living below the poverty level was nearly universal among both the groups[2]. Qualitatively though, fatal cases were from more marginalized families and surrogate socio-economic markers such as reduced net ownership supported this observation[2]. Amongst the remaining factors, delay in receiving treatment and the use of chloroquine (much in the way of unqualified healthcare providers) were most strongly associated with mortality. Thus, while malaria risk may be ecological, we determine its lethality.

These are not new thoughts. If anything the old literature far surpasses our treatment of causation in malaria outcomes. In his classic 1909 study on malaria in the same region of India, Rickard Christophers sought to explain the intense malarial condition of West Bengal tea plantations[3]. He catalogued mosquito vectors, parasite rates, vital events, weather, nutritional intake, commodity prices, and the tea industry economics over a period of two years. Eventually, he concluded, "One of the chief causes leading to increased intensity of malaria in the Duars is the fact that at the commencement of their life in the district all new coolies [tea workers] are placed under the disadvantages imposed by the present labor system." The defects in the system as they affect malaria - poor healthcare, poor housing, and insufficient pay to purchase adequate food - are carefully detailed and his prescription for malaria control is equally thoughtful: abolish the use of exploitative middlemen for labour recruitment and management. A similar effort to analyze the recurrent malaria epidemics of colonial Punjab attributed the variation in mortality during different cycles to acute hunger, reflected in food grain prices, rather than medical or entomological factors[4].

In summary, not all malaria deaths, in spite of a singular classification, are the same. A visiting traveller and a subsistence farmer may both die of malaria, but they died for different reasons and their deaths indicate distinct public health responses. This suggests a need to incorporate more information than just the aetiology. Classification of confirmed malaria deaths, which investigate distal causes or specify a resultant public health action, may be beneficial.

Who is counting?

Estimating malaria deaths presents several problems. Fundamentally, there are two choices for counting malaria cases and deaths - select a narrow definition and risk underestimation or select a broad definition and risk overestimation. The former is often based on routine surveillance while the latter on survey-based methods such as verbal autopsy or prevalence linked with cartography. Each choice has its own proponents and each constituency has vested interests in generating low numbers (managers of control programmes) or high numbers (grant-supported researchers). Bias exists and cannot be avoided. To illustrate this point, the National Vector Borne Disease Control Programme (NVBDCP) in India reports around 1,000 malaria deaths per year from its extensive surveillance programme[5]. The World Health Organization, with the endorsement of NVBDCP, estimated 22,000 malaria deaths using surveillance data[6], while the Registrar General of India calculated 71,400 deaths from systems of medical certification of cause of death and sample registration[6,7]. Finally, a team of researchers projected 205,000 malaria deaths in India during 2001-2003 using verbal autopsies among a national sample cohort[8]. Variation in the estimate of an order in magnitude does not inspire confidence.

Which method is the best? One can engage in lengthy debate on the merits of different methodologies[9]. But that is not the point. We must go beyond matters of technical dexterity and approach the problem from different angles. First, none of the estimates provide locally applicable data. All forms of estimation are an inadequate replacement for routine reporting of deaths. Unfortunately, improving death registration is usually assumed to be unfeasible and rarely subjected to focused effort. Second, the estimates, each of which is 'objective', vary considerably and depend on the position of the observer. The application of this concept to the enumeration of morbidity is a prominent example in Amartya Sen's original description of 'positional objectivity'[10]. Briefly, it is the idea that the world will not look the same, for example, from state-of-the-art laboratories in a capitol city and from the tropical heat of malarious villages. The theory allows for attempts at objective enquiry along with the notion that the resulting observations will be position dependent[11].

Accepting a position dependent view requires acknowledging the parameters which describe the platform of observation. In order to do so, some questions are necessary. Why are malaria deaths being counted? Is it to approximate an external reality or is it for public health usefulness? If we accept the latter rationale, the basis for evaluation changes. The consequent line of inquiry would seek to determine, for instance, whether the data can be acted upon. Or we would want to know if spending additional effort to improve counts will provide a proportional, or at least an acceptable, increase in value. Ronald Ross, commenting on the measurement of malaria, said as much, "Note to begin with that we can never obtain any such estimates exactly; and also that the degree of approximation towards the truth must always depend on the amount of time and energy we have to spare for the task…"[12]. Along this line of reasoning, only surveillance based approaches meet the criteria. Such methods provide up to date data relevant for smaller administrative units in which most control services are planned and delivered. While surveillance systems have certain limitations, efforts to improve their functioning would also strengthen the general health system.

Ultimately, since bias exists - let us be explicit: *(i)* the manner in which malaria deaths are defined reflects our understanding of causation and restricts the public health response to those deaths, and *(ii)* how and why malaria deaths are counted varies depending on the counter. Our figures therefore, in both meaning and magnitude, are not and will not be 'perfect'. This is acceptable. At the least, we should feel comfortable admitting what we do not know and seek public health utility in our work instead.

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