Causal chain mapping: a novel method to analyze treatment compliance decisions, with application to the elimination of lymphatic filariasis in Alor, Indonesia

Alison Krentel*[1] and Robert Aunger[1]

[1] London School of Hygiene and Tropical Medicine, London UK

*Address for correspondence: Alison Krentel, Department of Public Health and Policy, Public and Environmental Research Unit, Sexual Health Unit, London School of Hygiene and Tropical Medicine, Keppel Street, London WC1E 7HT United Kingdom, **Phone** +1 (613) 983 4863, **Fax:** +44 (207) 580 6507
Email: Alison.krentel@lshtm.ac.uk

Keywords:

Decision-making, semantic maps, compliance, Indonesia, mass drug administration, lymphatic filariasis

Running title:

Causal chain mapping used to describe decision making associated with LF treatment

Location of study: Alor District, Indonesia

Authors:

Alison Krentel PhD: Conceived the study, conducted the data collection, performed the data analysis, collaborated on the development of the causal chain maps, and drafted the manuscript. Address for correspondence listed above.

Robert Aunger PhD: Collaborated on the development of the causal chain maps and the analysis of the data via CCMs and reviewed the manuscript. Department of Infectious and Tropical Diseases, Vector Borne Diseases Biology Unit, London School of Hygiene and Tropical Medicine, Keppel Street, London WC1E 7HT United Kingdom, **Phone** +44 (207) 927, **Fax:** +44 (207) **Email:**Robert.Aunger@lshtm.ac.uk

Abstract (203 words)

Many public health programmes require individuals to comply with particular behaviours that are novel to them -- for example, acquiring new eating habits, stopping smoking, accepting immunisations or taking a new medication. In particular, mass drug administration programmes only work to reduce the prevalence of a disease if significant proportions of the target population take the drug in question. In such cases, knowledge of the factors most likely to lead to high levels of compliance is crucial to the programme's success. Existing models of compliance tend to either address interpersonal, organisational or psychological causes independently. Here, the authors present a formal method for analysing relevant factors in the situational context of the compliant behaviour, identifying how these factors may interact within the individual. This method was developed from semantic network analysis, augmented to include environmental and demographic variables to show causal linkages – hence the name 'causal chain mapping'. The ability of this method to provide significant insight into the actual behaviour of individuals is demonstrated with examples from a mass drug administration for lymphatic filariasis (LF) in Alor District, Indonesia. The use of this method is likely to help make any public health programme reliant on the adoption of novel behaviours more effective.

(6469 words)

1. Introduction

Many public health programmes require individuals to comply with particular behaviours that are suggested by external authorities such as doctors or public health officials. For example, patients may be recommended to acquire new eating habits, stop smoking, accept new immunisations or take a regimen of medications to alleviate a medical problem. In some cases, the effectiveness of a programme depends on many people adopting the advice of these authorities. Mass drug administration (MDA) programmes require a significant proportion of a population to comply with a suggested treatment, regardless of their infection status. In such cases, knowledge of the factors most likely to lead to high levels of compliance can be crucial to the programme's overall success. Finding out why people accept or reject the recommended course of behaviour is therefore a necessary component of effective programme design.

Existing models of compliance with MDA programmes for lymphatic filariasis (LF) tend to emphasise interpersonal variation (gender, socio-economic status, education), psychological factors (beliefs, attitudes) or organisational features (knowledge of drug distributor, time of distribution) as influencing treatment decisions. In southern India, Babu and Kar emphasized the organisational causes that might affect the coverage of, and compliance with, LF treatment. Factors considered were related to health services (supply, training of health care workers) and community organisation (participation and perception that the treatment is important) (Babu & Kar, 2004). Mathieu *et al.* described psychological factors in their findings from Haiti; specifically that knowledge of transmission via mosquitoes and knowledge about MDA acquired through exposure to mass media were shown to be associated with compliance (Mathieu, Lammie, Radday, Beach, Streit, Wendt et al., 2004). Education level has also been shown to have an influence on compliance (Kasturiratne, Premaratne, Pathmeswaran, de Silva, & de Silva, 2001). Ignorance about LF and treatment programmes has also been shown to have an association with compliance (Talbot, Viall, Direny, Beau de Rochars, Addiss, Streit et al., 2008). Another study combined both psychological and interpersonal effects, finding that when adjusted for all other factors, only the type of population (rural and urban), gender and belief that the MDA

programme is beneficial were associated with influencing drug compliance (Gunawardena, Ismail, Bradley, & Karunaweera, 2007).

In any one individual, factors relating to an individual's choice to comply may interact, based on personal experiences, beliefs, values and attitudes as well as external forces such as environment and other individuals. Indeed, taking a pill during a mass drug administration event is highly situated – a decision based on the individual's psychological and demographic traits, and the context of administration (i.e., whether public or in-house, directed by external authorities or local public health workers or family members). None of the existing models in the LF mass compliance literature discusses the interaction of these features and how they might combine to influence compliance; and no study, to date, has combined these potential causes into a single approach.

In order to understand better how these variables interact to guide decision-making, a novel technique was specifically developed for this purpose: 'causal chain maps' (CCMs). This technique allows an individual's decision-making process to be visually displayed for synthesis and easier interpretation. CCMs are based on semantic network analysis (D'Andrade, 1995), a technique for analyzing texts that infers cognitive associations between concepts from the primary data. These associations are then represented in a network graphic in which nodes in the network represent concepts, while the links connecting the nodes represent the type of the association between them (Carley, 1993). This structure is presumed to mirror the way in which knowledge is represented in long-term memory (Schank & Abelson, 1977). Comparison of these structures across individuals provides insight into the similarities and differences in relevant knowledge and attitudes (Carley, 1993).

Semantic network analysis has been extended in the CCMs from modelling psychological variables to include situational and behavioural variables – in particular, the environmental aspects of the situation when the decision is made (prevalence, method of distribution, persons involved in the MDA) as well as the behavioural outcome of the psychological process (e.g., compliance with the medical

advice or not). This general flow of causation – from environmental factors to personally defining features to psychological constructs to behaviour – is common in many current models of behaviour determination, especially the dominant class of health promotion models (e.g., the health belief model (Strecher & Rosenstock, 1997), theory of planned behaviour (Ajzen & Fishbein, 1980) and social cognitive theory (Bandura, 1986)).

This paper suggests that CCMs can be generally applied to most decisions about compliance in public health programmes, but a particularly important category is MDA programmes, which only work to reduce the prevalence of a disease if significant proportions of the target population take the drug in question. The utility of CCMs will be demonstrated using a case study from the elimination of lymphatic filariasis (LF) in Alor District, Indonesia, where MDA began in 2002 and continued every year until 2007. It is thought that treating between 75-80% of the total population living in a LF endemic area, excluding pregnant women and children under 2 years (Ottesen, 2000), for a period of 4-6 years is sufficient for elimination of LF (Babu & Satyanarayana, 2003; Ottesen, Duke, Karam, & Behbehani, 1997).

The authors will use the CCM methodology to analyze a selection of in depth interviews from Alor District to show the maps' ability to illustrate the interaction among influencing factors, as well as to predict an individual's compliance outcome. The paper concludes with some remarks concerning the general applicability and advantages of using this method for understanding the causes of compliance with medical regimens.

2. Causal Chain Mapping

2.1. Data collection aspects

Causal chain mapping is a technique to assist researchers to better understand the situational, environmental and psychological causes of medical compliance. As such, it requires researchers to collect information on a wider range of aspects of the treatment situation than is common practice. These data can be collected through a variety of methods, ranging from standard questionnaire responses to more in depth

and projective techniques, such as use of drawings or other means to elicit information from respondents concerning their decision-making. To be more salient, data collection procedures should refer explicitly to particular circumstances, such as the doctor's visit or visit of the MDA authorities, as well as to the individual's personal characteristics (presently sick or well, employed or not, female or male).

2.2 Analysis Aspects

The causal chain map is the end-product of several stages of analysis. The first stage includes the analysis of the interview tool; quantitative analysis of a questionnaire or the identification of themes and patterns in qualitative data. This research used Framework, a matrix developing method for ordering, synthesising and analysing the data (Ritchie, Spencer, & O'Connor, 2003). Framework requires that the researcher, through an iterative process, organises the emerging themes from the individualized data into a detailed matrix which provides an opportunity for analysis by theme (vertically) or by individual (horizontally). (Ritchie et al 2003) This method provides a comprehensive description of the participant's data; however one of its weaknesses is that it lacks a means to link themes or comments within the individual.

The second stage of analysis, on which this paper focuses, involves the production of a causal chain map (CCM) for each individual. Causal chain maps are graphical devices which have the following topographical features (see Figure 1): representations of the external social world (people involved in the decision-making event itself – in this case the mass drug administration (MDA)); the disease environment; the event (MDA); the individual's personal characteristics; knowledge about LF; beliefs about society; and personal experience with treatment and values.

Specifically, nine clusters of themes are represented in the map. Beginning in the upper left hand corner, there is a hexagon for prevalence area. Depending on the location of the individual, this will be marked "high" or "low" prevalence to reflect the local disease environment. The top centre of the diagram contains a description of the MDA event including information such as house to house or health centre distribution among others. In the upper right hand corner is a cluster of boxes

representing the individual's relevant social world. They include the individual's family, neighbours, community and religious leaders as well as the health staff in their village.

In the centre of the map, a yellow oblong oval contains the respondent's own characteristics: current health status, education, occupation, age and gender. Where they did not mention something about their status with respect to one of these characteristics, then the field remains as a general description only (e.g. personal health, education, occupation, age).

Below the individual's characteristics are three clusters of themes: "knowledge about LF", "beliefs about society" and "personal experience". Specifically, the purple cluster of themes about "knowledge about LF", relate to: cause and transmission, prevention, drugs and biomedicine and traditional medicine. It is important to note that knowledge used here refers to everything the individual knows or believes about the disease and its treatment; rather than biomedical or correct knowledge specifically. Knowledge and beliefs are treated as equivalent concepts without judgment about their correctness (Pelto & Pelto, 1997). The middle cluster, "beliefs about society", contains those categories relating to norms, reputation, authority (including government) and social roles (including gender). The green cluster contains categories relating to the respondent's "personal experience" with LF treatment, side effects and the health system. These experiences can be the respondent's own, those they observed personally or those which they have heard about.

At the bottom of the causal map is a long red square concerned with "values" – namely priority of health, fear/uncertainty, respect, economics, acceptance/fatalism and moral judgment on behaviour. The list of these values is not exhaustive, however these are the specific values which arose out of the interviews and are therefore included here.

Finally the green oval at the bottom called "compliance" refers to the outcome of the map – in this case, the act of taking the treatment.

During the process of analysis, a line is drawn between boxes in the diagram if the respondent made an explicit statement linking two or more of concepts or behaviours. The two types of lines used in the CCMs concern perceived factors affecting compliance within the community (represented by black lines) or the individual's personal reasons for compliance or non-compliance (represented by red lines). In order to be drawn as a red line, the statements from the interview must represent a sequence of factors leading from 'external' variables about the situation, through the map to the decision of compliance; providing an explanation of the individual's logic from the stimulus of the distribution event to their response in terms of compliance. These red lines are called "causal chains" and are likely to include the factors which effectively constrain the individual's decision-making process and determine their behavioural choice. Both the red and black lines linking specific factors to the compliance oval on the map have associated plus (+) sign or a minus (-) signs, depending on their positive or negative effect on compliance.

To illustrate the process of drawing the lines we suggest the following 2 examples. If an individual said "people were afraid to come for treatment because of side effects" a black line would be drawn from experience with side effects to fear to compliance; a minus (-) sign would be attached to the line, as the statement represents a negative influence on compliance. This line symbolises an individual's opinion about what influences compliance in his/her community. If another individual said "I swallowed the pills because I am well now and I cannot afford to get sick and miss work" then a red line would be drawn from personal health to economics to compliance with an associated plus (+) sign demonstrating the positive effect on compliance.

It is important to note that all connections are made only from the respondents' comments which explicitly link a belief or other factor to compliance, so the degree of interpretation on the part of the researcher is minimized by the mapping process.

The total of positive or negative values of the terminal links to compliance predicts the behaviour which was actually reported (compliance with treatment or non-

compliance with treatment). In cases where there are several complete causal chains, the greater number of values (positive or negative) attributed to them predicts the behavioural outcome. It should be emphasised again that the data itself determines how lines are drawn, so the predictive quality of the maps is an emergent feature of the method, rather than a criterion of the coding.

To demonstrate the utility of this method, we continue by describing a case study of MDA to eliminate LF in Alor District, Indonesia.

3. Case Study: LF in Alor District

Within the last decade, the elimination of LF has become an important priority in international public health. In 1998, the Global Programme for the Elimination of LF (GPELF) was launched combining the efforts of international research institutions, pharmaceutical companies and national health ministries with the specific goal of eliminating lymphatic filariasis as a public health concern by 2020 (World Health Assembly Resolution 50.29) (WHO, 2004).

The elimination of LF (in areas where loiasis and onchocerciasis are not co-endemic) depends on the participation of endemic communities worldwide in consuming one or two drugs (Diethylcarbamazine and Albendazole) in an annual mass drug administration (MDA) for the duration of 4 to 6 years (Babu & Satyanarayana, 2003; Ottesen, Duke, Karam et al., 1997). Prior to MDA, LF carriers may not know their infection status as only a percentage will develop chronic manifestations of LF. Furthermore, testing and diagnosis are not a pre-requisite for consumption of the drugs. Commonly cited barriers to achieving compliance with MDA are the difficulty of achieving and maintaining a sufficient coverage rate and a declining coverage rate due to initial adverse reactions to the medication (Evans, Stoddart, Condon, Freeman, Grizzell, & Mullen, 2001; Sunish, Rajendran, Mani, Gajanana, Reuben, & Satyanarayana, 2003). Challenges to LF elimination include: (1) convincing asymptomatic persons to comply; (2) maintaining high levels of compliance; (3) managing adverse reactions.

Research on compliance has focused on associated factors with compliance rather than on influences on the individual to comply. GPELF recognises the relevance of this information to its success and has called for increased research on individual motivations. In 2004, the international LF research community recommended that investigation into factors affecting compliance is an immediate need and listed it as part of a global strategic research plan (Malecela-Lazaro & Twum-Danso, 2004). By creating and using a novel technique to analyse how different themes interact in an individual, this paper proposes to simplify the analysis process whilst illuminating the reasons people report for compliance or non-compliance with MDA to eliminate LF.

3.1. The research site – Alor District

Alor is a small district with 13 islands in Nusa Tenggara Timur province in eastern Indonesia with a population of 168,965 in 2003 according to the Alorese Bureau of Statistics. There are two types of LF present in Alor District, *Brugia timori* and *Wuchereria bancrofti*. A survey in a highland area of Alor in 2002 showed a standardised population prevalence of 25% of microfilaria (mf) carriers (for *B. timori*) (Supali, Wibowo, Ruckert, Fischer, Ismid, Purnomo et al., 2002). The highest prevalence of mf positive persons was in men and women between 40 and 50 years (50% men and 38% women) (Supali, Wibowo, Ruckert et al., 2002). Surveys conducted by the District Health Authority from 1996-2000 showed that mf rates for W. bancrofti and B. timori ranged from 1.7 – 11.9% in 17 villages on Alor (personal communication Dinas Kesehatan Kabupaten Alor).

3.2. Data collection methodology

A quantitative survey was carried out in November 2004 in Alor District in order to identify the knowledge, attitudes and behaviour (KAP) of the population towards LF and its treatment after three years of MDA participation (unpublished data, A Krentel). The results of that study showed that there were reported influences on compliance which were not related to knowledge about the disease or its transmission and understanding of treatment efficacy. In order to understand further these stated

influences as well as to uncover other possible motivations, a series of 43 in depth interviews were carried out in Alor District in November 2005.

The sampling strategy used for the in depth interviews was purposive quota sampling. Equal quantities of respondents were sought for each of these factors: living in a high or no prevalence area, and being a (prior) complier or non-complier. In order to represent the population in Alor, the interviewers also attempted to reach a gender balance in the sample size. Finally, in order to account for possible differences between more populated areas and rural areas, the purposive sample included equal numbers of persons from both rural and urban areas.

An unscheduled, unstructured topic guide was designed to be referred to throughout the interview. Main topics included the respondent's perception of the cause and transmission of LF, description of the drug delivery system in respondent's village, what influenced them to take the treatment, perceptions about other people living around them and their reported compliance, perceived benefits and costs of the treatment and what were the most important reasons why they took the treatment. In addition to the topic guide, respondents were also asked to comment on a series of pictures depicting a woman complying with treatment and another woman refusing to comply.

All interviews were carried out in Indonesian by the author (A. Krentel), who had previously worked in Alor, accompanied by an Indonesian social scientist that provided assistance on translation and issues of clarity. Interviews were taped in accordance with permission granted by the respondent. Complete transcriptions of all interviews were produced by the author (A. Krentel) and 2 research assistants.

Ethical approval to conduct the study was obtained from the ethical review committee of the London School of Hygiene and Tropical Medicine and by the National Institute of Health and Development Research at the Indonesian Department of Health. All respondents signed an informed consent form and were given an information sheet concerning the specifics of the study as well as addresses to contact if more

information was required. According to Indonesian ethical requirements, each respondent was given a towel and a bar of soap as a token of appreciation.

The authors analysed 21 interviews (out of a total of 43, or roughly 50%) and developed individual maps for each one. These 21 individuals were selected randomly from the total sample according to the same criteria as the larger sample: compliance and prevalence area with equal representation of gender. The first author used interview transcripts to produce a Framework-based matrix of each interview. From this basis, the two authors independently reviewed the matrix data and each drew maps which were then compared. Inter-rater reliability between the two researchers was high in all cases and a final map was agreed through discussion, with reference to the original transcripts concerning any points of disagreement.

3.4. Causal Chain Mapping analysis – 3 examples

Three maps have been selected to demonstrate how causal chain maps represent the interaction of different factors and how they influence an individual's decision on compliance. The following vignettes result from the diagramming analysis itself. These narratives are descriptions of the diagrams themselves, based on going back to the interview material itself for the crucial statements which support the complete causal chains revealed in the diagrams.

3.4.1. A non-complying man from the district capital (Figure 2)

This first map is for a 57 year old non-complying man living in the district capital. He is a retired teacher with 6 children.

This man offered four positive influences on compliance (black lines) during the course of the interview. He demonstrated his understanding of the need for good compliance in the community in order for the drug to work. He reported that in one area, every person had to take the medication and if one person did not want to take it, then the disease could move because it is transmissible; so it was better if everyone took it (illustrated by the black lines from norms – compliance and from LF cause/transmission – compliance). In another statement (illustrated by the black line

from authority – compliance) he stated that if the program was from the government, then he had to accept it; as it was for public health. He also said that it was better to take the medication offered from the health centre to prevent LF. With these statements he demonstrated his knowledge of the disease and the MDA, the influence of the social norm to conform by taking the treatment and finally the authority of the government programme to command compliance.

He mentioned one negative comment about the LF drugs: they were chemically manufactured and therefore contained chemicals which he was not sure how they might affect his body (illustrated by the black line from drugs – fear/uncertainty – compliance). He added that it was better to take natural medication and to eat natural foods. He distrusted biomedicine due to its chemical properties.

With regards to the LF treatment, he reported taking the medication the first year of the MDA when it was brought to him by the health staff; however he said he saw no reason to take it then or to take it now. When his wife brought home the drug the year of the interview, he refused it. For him, traditional medicine and LF medicine had the same use – to prevent disease and keep him healthy. He told me he would continue to use traditional medicine (specifically papaya leaves, a bitter grass (for LF) and massage techniques) and that he would not get sick (illustrated by the red line between personal health – traditional medicine – compliance).

It is likely that his man thought he was complying with the core reasons behind the MDA (to eliminate LF), as seen through his statement that he should follow government programmes and his belief that he was preventing his community from LF because of his compliance with traditional medications.

3.4.2. *A complying man with a history of non-compliance from a rural village (Figure 3)*

A 37 years old farmer, who was married, had 4 children and lived in a village where he was head of his neighbourhood. His village is endemic for LF.

This man is a complier with a history of non-compliance; his statements revealed he had complied the year of the interview for the first time, after several years of non-compliance. He began his story saying he had initially tested negative for LF, and that was a sufficient reason for him to refuse treatment (illustrated by the red line from personal health – compliance). He explained that if there was no diagnostic test, then people would doubt the medication and would fear adverse reactions. He had heard that someone had died from side effects after the MDA. He believed this explained why some people in his community would not want to comply with LF treatment. (illustrated by a black line from side effects – compliance)

He offered some opinions on people's compliance. He described the norm to conform explaining if a non-complier saw someone taking the pills then they would want to take them too (illustrated by a black line from norms – compliance). He understood that people would want to take the treatment for prevention and cure of LF (illustrated by a black line from LF prevention – compliance).

Later in the conversation, he explained that he took the pills this year, because he had become the head of a neighbourhood and it was important for him to comply so that people knew this was a government programme (illustrated by the red route from farmer/community leader – authority – respect – compliance). He understood his own position as a role model and his effect on influencing others in his community to comply with treatment.

Based on these statements, it seems he changed his mind about complying based on his role as head of neighbourhood rather than a desire to prevent LF. His map illustrates his two positions (compliance and non-compliance) by giving two complete causal chains – one negative and one positive.

3.4.3. A non-complying woman from the district capital (Figure 4)

This woman was a 30 year old housewife, married with 3 children. She was an outsider to Alor, coming from a neighbouring island.

At the time of the MDA, the community health worker (CHW) brought the drugs to her house (illustrated by a black line from MDA – CHW) and did not explain anything about the drugs or the disease, leaving the drugs for the woman and her family to take.

The respondent reported that she forgot to take the pills which were in her house and that they still may be in the medicine cabinet. She added that she was too busy to take the medication (illustrated by the red lines from housewife – priority of health – compliance). She did give the treatment to her husband and children after they had dinner and she talked about the negative side effects they suffered from – going to sleep and not waking until the next morning (she said they were unconscious). These side effects frightened her (illustrated by the red lines from family – side effects – fear/uncertainty – compliance).

Despite her own non-compliance, this woman was aware of the norm to conform to compliance with treatment. She feared what would happen if everyone else did not comply and the disease spread; however she had heard that everyone had taken the tablets and she was the only one who had forgotten to comply (illustrated by the black line from norms – compliance). These comments suggest that she may have understood the protection (herd immunity) she gained from a complying community.

3.5. General results: Identification of significant factors affecting compliance

The 21 causal chain maps for compliance made visible some patterns of decision-making. Every map has at least one complete causal chain with either a negative or positive value indicating its influence on compliance. Some individuals' maps revealed that they had more than one complete causal chain, indicating that they were persuaded by two or more different sets of linked factors.

Not every map had a black line. Respondents' opinions about other motivations within their communities (black lines) seemed to be varied with the richness of the interview. Where respondents offered more information in the interview in general, there were more opinions about the other possible influences on compliance. This

does not suggest however that those maps with few or no black lines were not valuable interviews; merely that some individuals were more vocal and descriptive in their accounts than others. The fact that at least one complete causal chain could always be found also suggests that regardless of the interview quality, a suite of causal factors which is likely to have been responsible for the respondent's behaviour could be identified. At least with respect to its primary objective, the mapping method is robust with respect to interview quality.

The complete causal chains (illustrated by red lines) were more likely to involve statements about values and beliefs about society that through knowledge or personal experience with the disease or the treatment (see Figure 5). In fact, only 2 people in the cohort had a complete causal chain which began with the disease environment where they lived. This finding challenges the hypothesis that endemicity might have a strong influence on compliance; *e.g.* that people living in highly endemic areas would be more willing to comply with treatment while those living in areas with no disease would be less likely to comply. This was based on the assumption that people living in endemic areas would better understand their own risk for infection.

Only 4 individuals based their compliance on factors on the right side of the map: personal experience with treatment, side effects or the health system. All four reported experiences with side effects which negatively affected their decision to comply. This confirms experiences seen in other parts of Indonesia where early elimination campaigns suffered because individuals had negative experiences with adverse reactions associated with LF treatment (Oemijati, 1999; Putrali, Kaleb, Van Peenen, & Saroso, 1975; Sutanto, Boreham, Munawar, Purnomo, & Partono, 1985).

Within this cohort, 5 individuals based their decision to comply on factors related to their knowledge of the disease on the left side of the map. This pattern confirms the thematic findings on knowledge of aetiology and transmission of disease where individuals seemed in general to have a multiple and varied understanding of cause of disease, most often vague in biomedical terms. Two of these individuals spoke about their reason <u>not</u> to comply with biomedical treatment due to their adherence to traditional medicine which they relied on as prevention against LF. The remaining

three complied with treatment because of their belief that the drug would prevent disease.

There were 7 individuals who made decisions on compliance based on their present health status. This was an unexpected result as personal health was not referred to specifically during the interview. With the exception of one woman whose condition contraindicated her from taking the treatment (breastfeeding), 5 other individuals did not take the treatment based on their good health or personal health maintenance. One woman was sick at the time of treatment and did not receive the treatment. Two men reported that their personal health was good so therefore they saw no reason to comply with the treatment. There were also two men who reported regular use of traditional medicine as a way of maintaining their health and preventing disease. Only one man, a civil servant explained that taking the treatment would maintain his current good health status.

Complete causal chains for 10 individuals went through the centre group of factors – beliefs about society (norms, social reputation, authority/government, social roles/gender). The majority of the complete causal chains went through authority; while others included norms, social roles/gender and social reputation (in order of frequency). These societal factors were often associated with perceived consequences and benefits of complying or non-complying behaviour such as: achieving a good social reputation, satisfying one's social role as a man and provider by staying healthy, being a good leader by fulfilling responsibilities to provide a positive example to the rest of the community, respecting orders from authority figures or following the norm of conformity. Interestingly, the black lines (see Figure 6) representing the perceived influences present in the community also included societal factors. Not only did some respondents experience influence from the society around them, but respondents also perceived this to be an important influence for others.

For the majority of individuals (17), complete causal chains included values: priority of health, fear or uncertainty, respect, economics, acceptance or fatalism and moral judgment on behaviour. These values were derived from the interviews themselves. A fairly large number of complete causal chains (6) featured economic considerations.

The links to economics were varied: personal health, social roles, spouse, priority of health and occupation. The influence of economics in treatment was not something obvious at the beginning of this research; rather the map analysis showed the importance of economics as a positive or negative influence. For example, people are sometimes too busy working to seek treatment and do not want to risk a possible loss of income by seeking treatment during their work hours (negative influences). Furthermore, if people felt able to work then they did not feel the need to seek treatment. These negative influences on compliance reflect respondents' primary concerns about their economic stability – losing a day's work would not be an acceptable risk to take for the benefit of the treatment. None of these individuals were civil servants or worked in private enterprise – rather their income was based on a daily wage. There were also positive influences of compliance which were linked to economics. For one man, the risk of getting LF if he did not take the treatment was too costly for him in economic terms – who would pay for his operation? He also felt responsible for the economic livelihood of his household and if he is sick with LF, then he would not be able to provide for his family.

Outside influences connected to complete causal chains reflect the holistic approach taken in the MDA campaign. In the MDA in Alor, community leaders (religious, governmental, cultural) were often enlisted to assist with promotion of compliance with the treatment. In addition, with the often public nature of the distribution – following church or mosque services, in schools, at health centres – crowds would be drawn to the event and the perception that everyone was complying would be propagated.

Aside from the public nature of the MDA, the closer circle of neighbours and family was also important as influencing factors on compliance. These people offer direct experience (both negative and positive) about the treatment. In several cases observing the side effects in the family was enough to influence some respondents to avoid treatment. Others turned to their neighbours for advice before taking the treatment.

The divergence between the composite maps in Figures 5 and 6 reveals the difference between respondents' perceptions of what influences those around them (black lines shown in Figure 6) and what actually influences them (red lines or complete causal chains shown in Figure 5). While both composite maps show the perceived and real importance of beliefs about society and its influence on compliance; respondents perceived personal experience and knowledge to have a greater influence than they do in reality. Furthermore, respondents expected external influences to play a more significant role in motivating individuals to comply than they actually do. Finally, as seen in Figure 6, respondents did not perceive personal characteristics as playing a role in predicting compliant behaviour whereas in their own accounts (Figure 5), their health, job status and sex played an important role in their decisions to comply.

4. Conclusions

Methodological

The use of causal chain mapping constitutes an innovative approach to the analysis of discursive interviews concerning compliance with an externally authorized health procedure. It provides an opportunity to identify in the data those statements of crucial importance to an individual's logic and influence on compliance, without isolating them from the context of the individual. These few statements are taken amidst details from pages of transcripts from the individual interviews and; once these themes or factors are placed on the map, the researcher is better able to find relationships among statements which may have not seemed related during the interview. On the map, links can be drawn which further reveal influences on behaviour. By analysing the cohort of maps, the researcher is able to draw conclusions and observe patterns within the individual's account which may not be as readily perceived in the thematic evaluation. This provides an opportunity to further generate as well as to check previous hypotheses.

Causal chain mapping also shows the effects (positive or negative) that specific factors have on compliance for each individual. These values give the researcher a clear and succinct picture of the relevant influencing factors without some of the detail and complexities which are inherent in the interviews. Although these complexities are essential to the analysis of any research question, understanding the

effect of these influences at the individual level can be complicated. The maps allow the researcher the ability to see which factors, at the individual level, take precedence in directing behaviour. Then, commonalities in the relevance of these factors can be assessed by comparing maps across individuals, to see which kinds of factors are most important in the population as a whole. These factors can then be targeted during intervention design to ensure maximum levels of compliance.

The limitation of this research is reflected in its novelty. The causal chain maps have only been tried within the field of MDA for LF elimination. In order to further assess the robustness of this new methodology, it is recommended to test it with other research questions where in depth interviews are used to determine one time occurring health behaviours such as vaccine uptake, helminth prevention, MDA for onchocerciasis, purchase of an insecticide treated bednet.

Thematic

One of the main patterns arising from this research is the strong presence of non-health related factors influencing people's decision-making processes. Traditional health promotion theories often root behaviour in knowledge and perception of risk (e.g., the Health Belief Model (Strecher & Rosenstock, 1997)). An examination of these maps shows that in fact, there are many other factors which seem to have a more important effect on decision-making, including fitting in with peers (norms), having a good reputation by following authority, protecting yourself from sanctions (following authority), feeling safe, protecting your family, neighbourhood or village from LF by complying with treatment, etc. Health-related benefits, on the other hand, are represented by prevention of disease or cure of an existing condition. Although some people do express this as a primary influence, the majority of the respondents whose maps were examined do not mention this is their primary reason to comply. Their expressed influences are more related to the non-health related benefits of compliance.

Furthermore the overall pattern suggests that social factors weighed heavily on respondents' minds – often more heavily than their own condition or beliefs when it came to compliance: what others were doing was seen as important. One implication

of this finding is that MDA in similar societies (rural, agricultural, patriarchal) should be implemented publicly where possible, so that this need to conform to group norms can be leveraged as a reason for each individual to comply.

Other thematic conclusions arose from the maps' ability to reveal new relationships amongst factors as well as dispel earlier hypotheses. The maps demonstrated the lack of importance living in an endemic area had on an individual's compliance. This was initially thought to be an important consideration in decision-making. Analysis of the maps also revealed the importance that economics and personal health each had in determining compliant behaviour in the individual. Evaluating the people involved in influencing decision-making revealed a cross-section of individuals – from village leaders to children. This provided a basis of understanding for the creation of the strong norm of conformity which has been described here.

The examination of the composite maps revealed simply the differences and similarities within this cohort between the perceptions of important factors influencing compliance (black lines) versus the reality of the respondents' own reasons for complying with treatment (red lines – causal chains). By better understanding both of these concepts, MDA campaigns can more effectively target populations by creating effective messages which will include both real and perceived influences.

Causal chain mapping has proven to be an effective and useful method to determine the influences importantly affecting an individual's decision to comply with MDA for LF elimination. The use of this method is likely to help make any public health programme reliant on the adoption of novel behaviours more effective. However, validation with other samples and with respect to other medical problems is recommended.

Figures
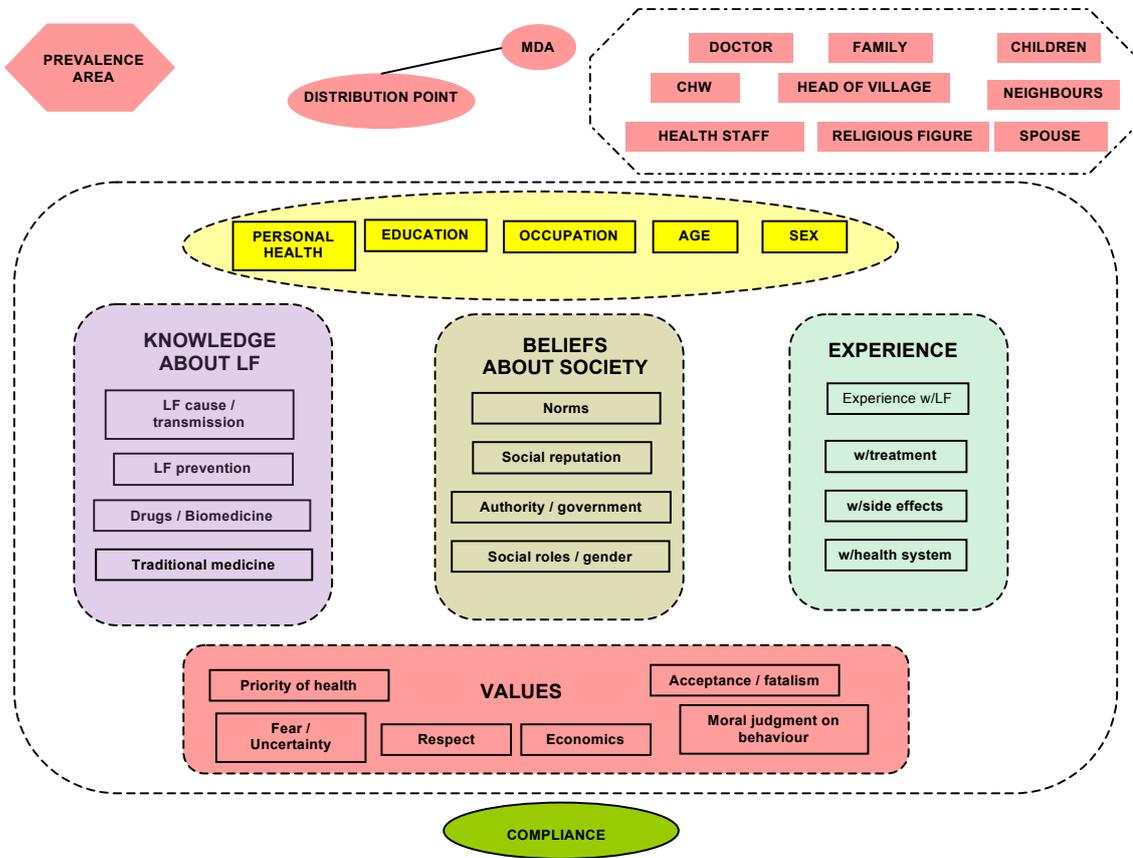
Figure 1: Causal chain map

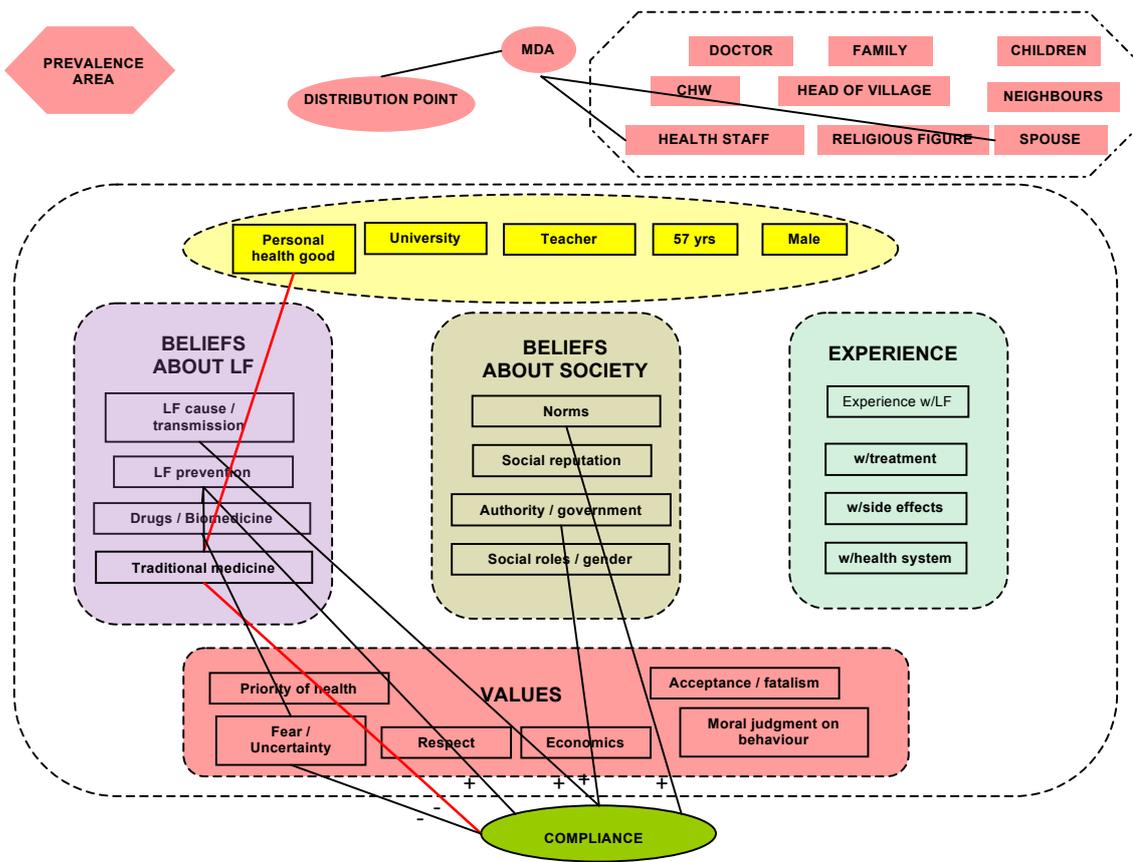Figure 2: A non-complying man from district capital

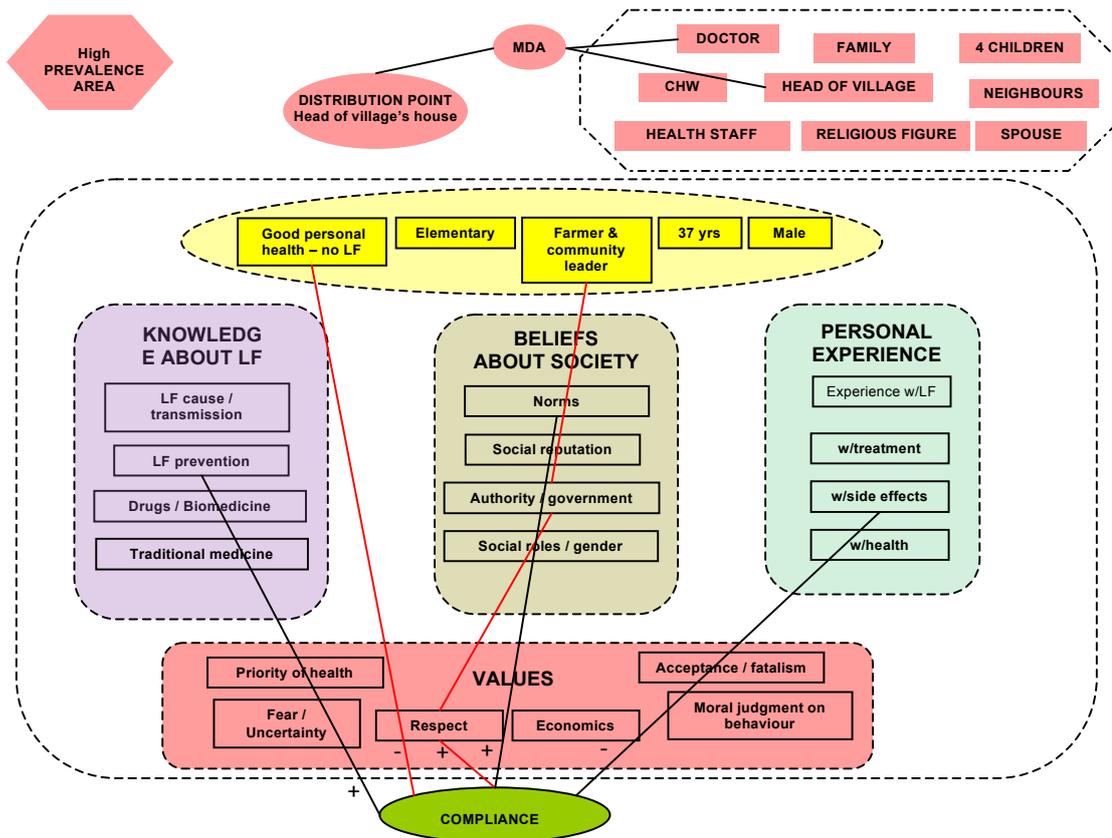Figure 3: A complying man with a history of non-compliance

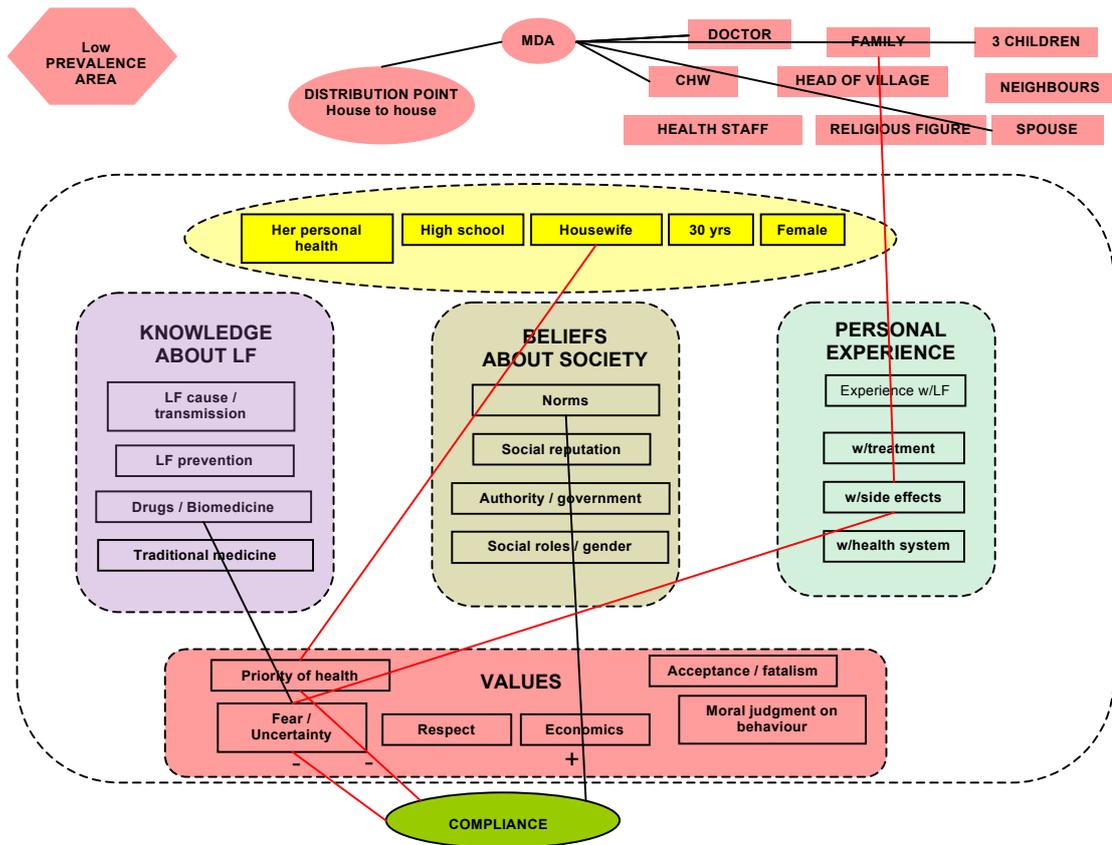Figure 4: A complying woman from district capital

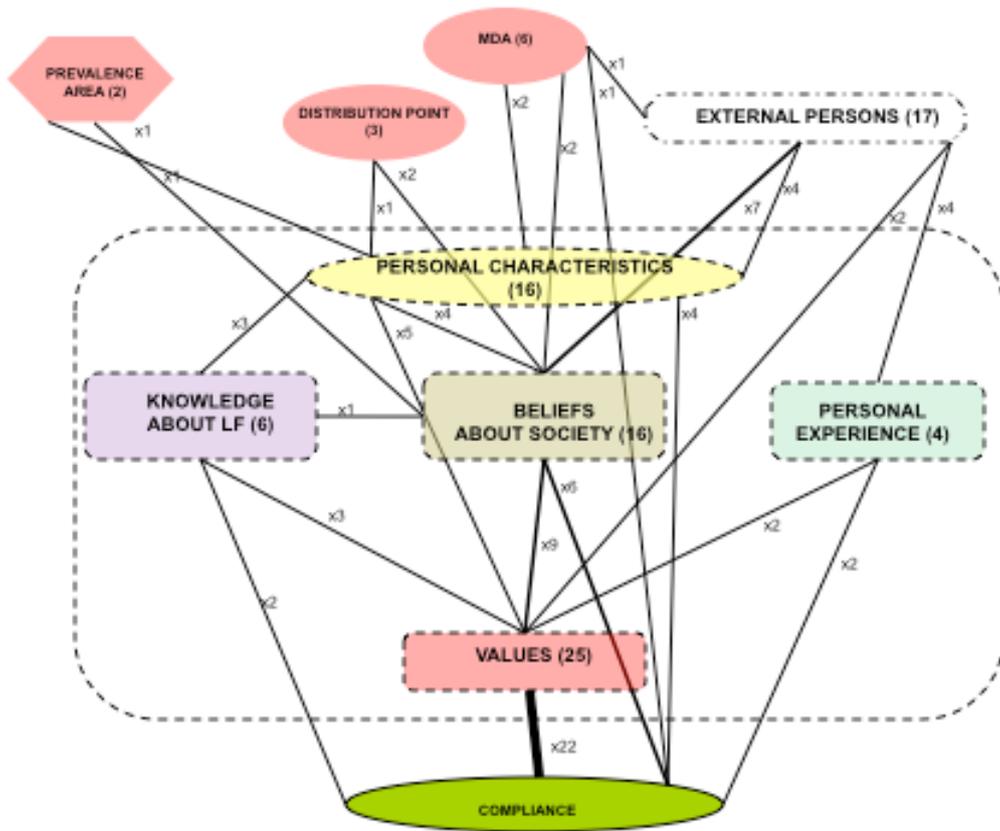Figure 5: Composite map of complete causal chains (red lines) from 21 maps

Figure 6: Composite map of perceived influences on compliance (black lines) from 21 maps

References

Ajzen, I., & Fishbein, M. (1980). *Understanding Attitudes and Predicting Social Behavior* Englewood Cliffs, NJ: Prentice-Hall

Babu, B.V., & Satyanarayana, K. (2003). Factors responsible for coverage and compliance in mass drug administration during the programme to eliminate lymphatic filariasis in the East Godavari District, South India. *Tropical Doctor*, 33(2), 79-82.

Babu, B.V., & Kar, S.K. (2004). Coverage, compliance and some operational issues of mass drug administration during the programme to eliminate lymphatic filariasis in Orissa, India. *Tropical Medicine and International Health*, 9(6), 702-709.

Bandura, A. (1986). *Social Foundations of Thought and Action: A Social Cognitive Theory* Englewood Cliffs, NJ: Prentice Hall

Carley, K. (1993). Coding choices for textual analysis: A comparison of content analysis and map analysis *Sociological Methodology*, 23, 75-126.

D'Andrade, R. (1995). *The Development of Cognitive Anthropology* Cambridge: Cambridge University Press

Evans, M., Stoddart, H., Condon, L., Freeman, E., Grizzell, M., & Mullen, R. (2001). Parents' perspectives on the MMR immunisation: a focus group study. *British Journal of General Practice*, November, 904-910.

Gunawardena, S., Ismail, M., Bradley, M., & Karunaweera, N. (2007). Factors influencing drug compliance in the mass drug administration programme againes filariasis in the Western province of Sri Lanka. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, 101, 445-453.

Kasturiratne, K.T., Premaratne, B.A., Pathmeswaran, A., de Silva, N.R., & de Silva, H.J. (2001). Compliance with the mass chemotherapy program for lymphatic filariasis. *Ceylon Medical Journal*, 46(4), 126-129.

Malecela-Lazaro, M., & Twum-Danso, N. (2004). 2.4 Program Implementation. *American Journal of Tropical Medicine and Hygiene*, 71, 16-19.

Mathieu, E., Lammie, P.J., Radday, J., Beach, M.J., Streit, T., Wendt, J., & Addiss, D.G. (2004). Factors associated with participation in a campaign of mass treatment against lymphatic filariasis, in Leogane, Haiti. *Annals of Tropical Medicine and Parasitology*, 98(7), 703-714.

Oemijati, S. (1999). Current Situation of Filariasis in Indonesia and its control. Jakarta: World Health Organisation.

Ottesen, E.A., Duke, B.O., Karam, M., & Behbehani, K. (1997). Strategies and tools for the control/elimination of lymphatic filariasis. *Bulletin of the World Health Organization*, 75(6), 491-503.

Ottesen, E.A. (2000). The global programme to eliminate lymphatic filariasis. *Tropical Medicine and International Health*, 5, 591-594.

Pelto, P.J., & Pelto, G.H. (1997). Studying knowledge, culture, and behaviour in applied medical anthropology. *Medical Anthropology Quarterly*, 11, 147-163.

Putrali, J., Kaleb, Y.M., Van Peenen, P.F.D., & Saroso, J.S. (1975). Mass Treatment of Malayan filariasis in the Gumbasa irrigation area of Central Sulawesi.

Southeast Asian Journal of Tropical Medicine and Public Health, 6(2), 206-210.

Ritchie, J., Spencer, L., & O'Connor, W. (2003). Carrying out Qualitative Analysis. In J. Ritchie, & J. Lewis (Eds.), *Qualitative Research Practice: A Guide for Social Science Students and Researchers* (p. 336). London: SAGE Publications.

Schank, R., & Abelson, R. (1977). *Scripts, Plans, Goals and Understanding: An Inquiry into Human Knowledge Structures.* Oxford: Erlbaum

Strecher, V., & Rosenstock, I. (1997). The Health Belief Model. In K. Glanz,F. Lewis, & B. Rimer (Eds.), *Health Behavior and Education* (pp. 41-59). San Francisco: Jossey-Bass Publishers.

Sunish, I.P., Rajendran, R., Mani, T.R., Gajanana, A., Reuben, R., & Satyanarayana, K. (2003). Long-term population migration: an important aspect to be considered during mass drug administration for elimination of lymphatic filariasis. *Tropical Medicine and International Health*, 8(4), 316-321.

Supali, T., Wibowo, H., Ruckert, P., Fischer, K., Ismid, I.S., Purnomo, Djuardi, Y., & Fischer, P. (2002). High prevalence of *Brugia timori* infection in the highland of Alor Island, Indonesia. *American Journal of Tropical Medicine and Hygiene*, 66, 560-565.

Sutanto, I., Boreham, P.F.L., Munawar, M., Purnomo, & Partono, F. (1985). Adverse Reactions to a single dose of Diethylcarbamazine in patients with *Brugia malayi* infection in Riau Province, West Indonesia. *Southeast Asian Journal of Tropical Medicine and Public Health*, 16(3), 395-399.

Talbot, J.T., Viall, A., Direny, A., Beau de Rochars, M., Addiss, D., Streit, T., Mathieu, E., & Lammie, P.J. (2008). Predictors of Compliance in Mass Drug Administration for the Treatment and Prevention of Lymphatic Filariasis in Leogane, Haiti. *American Journal of Tropical Medicine and Hygiene*, 78(2), 283-288.

WHO (2004). Strategic Plan 2003-2005: Challenges of scaling up In G.P.f.t.E.o.L. Filariasis (Ed.) (p. 26). Geneva: World Health Organization.