WORKSHOP REPORT

Evidence base for public health interventions to reduce disease burden for climate sensitive diseases
ECDC, Stockholm 16th and 17th June 2011

Summary

In the WHO report protecting health from climate change: global research priorities (2009), it has been stated “There is a lack of targeted, systematic reviews to identify and assess the effectiveness of interventions to control key climate-sensitive health risks, for example, for the control of vector-borne diseases, or heat health action plans”. To address this gap, the health workpackage within the RESPONSES project has conducted systematic search for public health interventions to reduce disease burden for high priority climate sensitive diseases including vector-borne, waterborne and heat stress diseases. The results of this investigation will be published shortly. In addition, a workshop with the same theme was hosted at ECDC and a panel of climate change, public and veterinary health and evidence base medicine experts attended. In this report, we present the benefits of evidence base for assessing the effectiveness of public health interventions, research gaps and future recommended research plans to allow successful preparedness and adaptation of the health sector to the inevitable climate change.

1. Introduction

There is an increased body of evidence for the adverse effects of climate change on human health. Numerous publications in the peer-reviewed and grey literature have highlighted those diseases that are likely to become greater concerns to public health in a warmer world. On the other hand comment and advice on what public health agencies should be doing to protect their populations has been far less forthcoming. This needs to be tackled as adaptation plans are extremely important in this context. Nevertheless, several international and national health organization/systems have issued best practice guidelines to prevent the uprising risks to human health from a changing climate. However, most has been general rather than specific. Even where specific advice has been given the evidence base supporting the effectiveness of that advice has been unclear, lacking, or even indicates that the recommended intervention has little or no value.

2. Workshop objectives

This workshop held at The European Centre for Disease Control in Stockholm aimed to bring together researchers, public health practitioners and policy makers to discuss the evidence base for interventions aimed at preventing diseases that are likely to become more prevalent in a warmer world. The workshop focussed on those diseases that may become emergent or re-emergent in Europe and North America in the coming decades.

The aim of the workshop was to:

- Consider relevant systematic reviews covering interventions designed to prevent climate sensitive diseases, particularly heat stress, vector borne diseases and waterborne diseases.
- Assess what interventions the evidence base supports as being effective, not effective or where the evidence base is insufficient to make a judgement.

- Make recommendations about what future research is needed to strengthen the weaknesses in the evidence base.

3. Funding

The workshop was funded by the RESPONSES project (European responses to climate change: deep emissions reductions and mainstreaming of mitigation and adaptation) (Grant agreement number 244092), under the FP7 programme of the European Commission.

4. Main findings of the workshop

4.1 Climate sensitive diseases

An assessment report entitled scoping document on health has been prepared as the first deliverable D7.1 of the Health workpackage within RESPONSES project. The report objective was to identify diseases/public health concerns that are likely to be exacerbated in a warmer world on a global scale but with a particular focus on Europe. These were classified as vector-borne diseases, waterborne diseases and extreme weather related diseases. Climate change has been predicted to significantly change the distribution of the following vector-borne diseases: West Nile fever, dengue, chikungunya fever, malaria, leishmaniasis, tick-borne encephalitis (TBE), lyme borreliosis, Crimean-Congo haemorrhagic fever (CCHF), spotted fever rickettsioses, Yellow fever and Rift Valley fever. For waterborne diseases, most climate change models predict that the main diseases that may be impacted on by climate change can be classified as being one of the following categories: risks from consumption of faecally polluted drinking water, risks associated with inadequate access to water, risks from bathing in faecally polluted surface waters, Cholera, risks from cyanobacteria affecting both drinking and recreational waters and finally risks from non cholera vibrios, especially *V. vulnificus* and *V. parahaemolyticus* in marine waters. For

extreme weather events, the main adverse health effects were associated with Heat waves and floods.

4.2 Evidence based medicine

The nature of evidence and the role of systematic reviews were discussed. Evidence based medicine is commonly used for clinical decision making, where the highest quality evidence is rigorously compiled and assessed, using information on the validity of that evidence and effect size of any risks and benefits of a treatment to drive optimal clinical decisions. Systematic reviews are increasingly used to provide the underpinning evidence for evidence based medicine as they are of highest quality on the hierarchy of evidence pyramid and their rigorous assessment of validity and effect can be translated into the strength of recommendation for a particular treatment.

Systematic reviews ask clear and explicit questions, pre-specify their inclusion criteria and methodology, use reproducible methods, search thoroughly to include all relevant studies, assess the validity of those studies, collate data on important outcomes and adverse events, synthesise the results (sometimes including meta-analytic summary) and present the data in an accessible way, thereby summarising a huge amount of primary data.

Public health interventions are more difficult to conduct and to interpret than clinical studies due to the increased complexity of interventions and need for larger sample sizes in preventive interventions. In addition, public health interventions may reflect cultural diversity more clearly, and so are more heterogeneous in terms of populations and interventions, making meta-analysis problematic, and increasing the need for exploration of heterogeneity through sub-grouping and meta-regression techniques. Subsequently, this influences the availability and quality of evidence in this field.

4.3 Public health interventions for climate sensitive diseases

As climate sensitive diseases are not emerging diseases per se and have been around for a long time, public health interventions have been implemented to reduce the disease burden mainly in endemic areas. We focussed on public health interventions for vector-borne diseases, waterborne diseases and heat waves because in our initial review they were the main climate sensitive diseases and also because for these areas, systematic reviews have already been published.

4.3.1 Vector-borne diseases

There is a general consensus that systematic reviews are important to judge the quality of evidence. However, the main limitations for increased number of systematic reviews as mentioned by the expert group attending the workshop were the lack of suitable primary studies, the amount of unpublished work (such as risk assessments for policy makers or various national reports) and the barrier of publication language. A way to resolve these issues might be to involve country representatives in research and meetings, employ translation services and conduct more primary investigations. In addition, it has been highlighted that the study design of several published investigations has been chosen mainly for epidemiological purposes and may not be ideal for policy making.

The lack of interventions can also be classified as the chicken and egg problem. Do you implement a public health intervention before a dengue outbreak in Europe (for example) or do you wait for the outbreak, implement interventions and then see which interventions are most effective. If you take a precautionary approach then you are unlikely to have a strong evidence base to work with.

There is extensive data about vector distribution in Europe and for future projection of vector establishment under various climate change scenarios. It has been suggested that some studies may be developed into predictive models for vector-borne disease but this is hindered by a big gap in basic

knowledge of vector ecology. This issue can be solved by in depth study of biology of vectors, which may allow direct correlation between vector habitat and disease risk.

Another issue raised was the feasibility of extrapolating results from studies in one country/vector to others. Context of interventions is extremely important. This is particularly important considering the heterogeneity of the biogeographic regions in Europe. In addition, the nature of public health interventions seems to be different amongst European countries/cities within the same region. It has been emphasized that public health measures need to be adapted to cultures and communities to ensure acceptance and effectiveness (such as acceptability of chemical intervention campaigns). This does not diminish the value of learning from local populations in endemic areas who have been combating vector-borne diseases for decades. However, importing these measures, without prior tuning and adaptation to national settings, would be a naive approach because issues in Europe may be different than in low income countries. In addition, European countries and people are wealthier and could be less interested in getting involved with vector-borne disease interventions.

There are obvious differences between various types of control measures: outbreak control can be considered late control, disaster preparedness is an earlier type of control which should incorporate learning experience and structured analysis and endemic control which is a continuous process. All approaches have different strategies, objectives and implications. Outbreak control should be considered a learning opportunity; it is obvious that a big epidemic would put the current control measures to the test. In such circumstances, the control measures with best evidence of effectiveness should be urgently implemented, but also further investigations such as case control studies and randomised control trials should take place to address the knowledge gap in primary data for some interventions. These studies should be consciously designed, fully approved and ethically feasible. A plan for these studies needs to be developed in outline now, and ethics gained in

some way, so that the studies are ready to put into action quickly and at the same time as control measures.

A way of addressing the lack of systematic reviews in the field of vector-borne diseases would be to study vector control in animal health as in general veterinary entomology has been studied more systematically. It is also acknowledged that ecological studies of insect vectors need a longer timeframe to be conclusive. It has been suggested that entomological surveillance should be associated with serological surveillance, but this might be costly and more difficult to implement.

It has been mentioned that interventions seeking to alter human behaviour are likely to be effective to limit the adverse health effects of climate change. Such educational interventions would require media involvement. The type of media needed to reach several age groups and societal levels was discussed. However, the effectiveness of such methods was debated based on previous work suggesting only short-term effect and because of the tendency to science mistrust from the general public.

Some participants argued that given *the particular nature of public health interventions for vector-borne diseases, systematic reviews may not necessarily be a good way of judging effectiveness*? A way of addressing this issue is to adjust the evidence base to vector-borne diseases by adopting alternative indicators of biological plausibility and effectiveness indices, identify a broader definition of evidence, apply a multidisciplinary approach to evaluate the body of evidence and finally involve stakeholders. The integration of social sciences, economics and political sciences might be useful to better assess the effectiveness of public health interventions to reduce the disease burden of climate change. It has been stated that political scientists are used to work with uncertainty and a certain degree of expertise in handling uncertainty might be beneficial for the public health sector. However, the main limitation of this concept is the trait of the public health

sector, its implications, interactions and the long term effect of health policies. Integrating economical evaluations can be a more realistic option as cost-benefit analysis and return on investment would clearly assist policy making in health. Once the effective measures for vector-borne diseases have been identified, their successful implementation might require a legal framework at the country level.

4.3.2 Waterborne diseases

The data presented in various reports suggest that the impact of climate change on the quality of water supplies in Europe is negligible mainly because of the availability of adequate infrastructure and detection and treatment procedures. The main impact however, is likely to be related to extreme weather events mainly floods and droughts, which can impair water quality and result in gastrointestinal diseases. In addition, floods are often associated with psychological sequelae and mental health problems as shown in several publications. However, the literature about the health impact of droughts is scarce. To compensate for the lack of literature, WHO Europe issued a guidance document on water supply and sanitation in extreme weather events. Considering that drought is the main challenge facing some European countries, intervention measures to prevent drying of water supplies should be implemented urgently. The lack of systematic reviews investigating the adverse health effects and/or intervention measures for floods and droughts is showcased by the nil result of our systematic search for these two extreme weather events.

Some advice about adapting to droughts has been issued such as that on water reuse. However, if grey water is used for an inadequate activity, it can be associated with increased risk of waterborne diseases. In addition, water saving measures such as banning of hose pipes during drought and intermittent piped water supply are likely to increase the risk of introduction of contaminants. The issue of drought seems to be exacerbated in some areas of the Mediterranean, mainly due to touristic activities where a tourist is likely

to consume ten times more water than a local. On the flood adaptation side, flood protection plans on land use and building developments should be implemented in vulnerable areas.

A few European citizens rely on small private water supplies. The issues facing these people are different from people relying on mains water sources. A concern about water quality and water saving procedures for this subpopulation has been raised.

To address the lack of primary studies in public health interventions for climate sensitive diseases, retrospective investigations are an opportunity to learn lessons from previous outbreaks and improve action and prevention plans. In addition, a good way to improve our knowledge is to take advantage of the occurring event, for example, if heavy rain is forecast, it should be considered a valuable opportunity to study disease risk or effectiveness of interventions. Well designed studies fit for the purpose of the investigation should be designed in advance and implemented as part of emergency action response. This approach if integrated into routine procedure for various extreme weather events will generate a considerable amount of primary data, which will then feed into long awaited systematic reviews for these extreme weather events. Another suggested way to address the limited amount of primary studies was the need for rapid response grants to fund extra studies and generate more results, which would allow accurate assessment of the impact of climate change and extreme weather events on these climate sensitive diseases.

It has been suggested that while the required amount of data is generated and because of the lack of high quality studies, expert opinion should be used for decision and policy making. The key is to develop interventions using lower forms of evidence (e.g. expert opinion, biological plausibility) and then, rigorously monitor and adapt them as new evidence becomes available. In addition, because of the nature of expert opinion and the low grading on the hierarchy of evidence pyramid, these decisions need to be evaluated regularly. Additionally, it has been noticed that expert opinion can be biased

because of conflict of interest. This is particularly relevant for waterborne diseases because the water filters industry is a highly competitive commercial field. It is therefore likely that studies funded by a particular company promoting its filters, may preferentially show results supporting the efficiency of such filters.

It has been mentioned that there are two types of interventions: preventative or prophylactic interventions aiming at preventing the contamination of water supply and treatment/curative interventions aiming to stop the contamination of the water supply and limit the spread of the infection. Each intervention has different procedure, target and benefits and depends on local resources, expectations and culture. A sound evaluation and evidence based studies should be carried out to evaluate the effectiveness of these interventions. Ideally, both interventions should be available on a national and local level and depending on the situation, the appropriate intervention should be implemented for immediate use especially in emergency settings. It is important in evaluating such interventions that the details of the intervention are published in full (websites can be used to supplement published data) so that the nuances of intervention types in specific cultural settings can be evaluated over time, as well as the more general approaches. For example, in some settings, targeting interventions at women may be more effective, in others targeting information or resources at men may work better, in others using schools as intervention points may be best, and this can be assessed across a range of public health issues in those regions. On the other hand, we may be able to generalise some techniques across many settings, such as that when we provide only advice we are less effective than when we also distribute effective tools (such as bed nets or bottled water or drought resistant seed).

There is a necessity for combined central action and individual action to limit the adverse effects of climate change. For example during floods, when water is likely to be contaminated, a central action is needed to ensure clean water is returned to the system as fast as possible. In addition, information should be made available to individuals from a central trusted body on the possibility

of contamination in the water and how to deal with this (e.g. boiling, bottled water, using distributed supplies). Individual action is needed to perform the advised actions (boiling water, keeping vulnerable people safe and informed). The need for both elements is relevant in most situations.

For vector-borne diseases, the value of an intervention proven to be effective in a particular setting (small water supply, developing country) does not necessarily mean that the intervention will be effective in a different setting. Therefore, context specific evaluation needs to be carried out before deciding to implement a particular intervention for waterborne diseases.

4.3.3 Heat waves

There are heat health action plans in place for many European cities. These plans were implemented after the European heat wave of 2003. To ensure better effectiveness, these action plans should be evaluated. A study for a Masters degree in the Netherlands aiming to evaluate the Dutch heat health action plan is ongoing. The evaluation procedure included interviews of ministers, health care organizations, stakeholders and elderly caretakers. The evaluation process targeted the following aspects: content of the current heat plan (2007), the aims of the heat plan, the clearness of the plan, the effectiveness of implementation of the heat plan, the planned update of the plan and finally the availability of evaluation procedure of the current heat plan. The evaluation of national heat health action plans is considered extremely useful especially that several heat health action plans were hastily implemented at the national level as an emergency response to the emerging threat. It has been suggested that the two key players of the heat action plans i.e. meteorological and health institutions should not only be involved in organizational implementation but also in the evaluation process by sharing and critically reviewing the procedures in place. Following the evaluation, data should be updated and protocol/guidelines should be modified to ensure optimal efficacy. Subsequently, the updated heat plan should also be evaluated using the same procedure.

A common issue for heat plans is the accurate definition of heat wave. The temperature threshold and the duration of high temperature can be difficult to define as it can be location and population dependant. In addition, temperature forecast and records tend to be central and therefore, may not be representative of remote areas.

It has been acknowledged that extensive meteorological and mortality data are readily available for most European cities. However, it would be extremely useful to link temperature and mortality data per city as this would improve our understanding of the direct relationship between these two variables and also evaluate the accuracy of the alerts. For comparability purposes, it is crucial that data collection and reporting are standardized at the European level.

A recurrent issue for heat action plans is how to reach the high risk group, mainly elderly people who are usually socially isolated. The usefulness of alternative communication systems (radio, bank of landline numbers) has been noted and also the added value of continuous information campaigns versus seasonal campaigns. However, even if the information reaches the targeted population, there was a concern about the effect of self perception of vulnerability on behavioural changes. The expert audience of the workshop concluded that for a message to be effective, it should be transmitted adequately, reaches the target audience and incorporated by the persons at risk. Therefore, it is extremely important to include evaluation of the effectiveness of communication in the overall assessment and approval of national and regional heat health action plans.

It has been highlighted that vulnerable groups should be included in research studies investigating the effectiveness of heat wave interventions. However, a main limitation that will certainly face these studies would be how to evaluate effectiveness for this high risk group. The reduction of DALYs (Disability Adjusted Life Years) is commonly used in public health and health impact assessment to evaluate the effectiveness of a given intervention. However, this measure by its nature gives more value for the lives of young and healthy

subjects. Therefore, the number of years saved for elderly or ill health people would confer a reduced DALYs value, which would then underestimate the effectiveness of the intervention being evaluated. This characteristic highlighted the limitation of this measure and the increased concern about the possible unethical nature of DALYs for some health issues. It has been concluded that alternative measures of effectiveness of interventions should be formulated.

During a heat wave and because of the emergency nature of the event, it is helpful to use the existing alert systems such as routine symptomatic surveillance networks. In addition, such surveillance can act as a surrogate/proxy for heat related mortality. However, the interpretation of such relationship should be undertaken carefully as the proxy can be unreliable when other factors contribute to the observed variation. Nevertheless, excess mortality is likely to represent an underlying problem and should trigger public health responsiveness. In this context, it has been suggested that an interface with health systems would allow real time follow up of the registered mortality which can be a faster process than waiting for official reports.

As most European cities have already experienced heat waves, several measures have been implemented. However, the value and effectiveness of a single intervention can be difficult to disentangle. In addition as it has previously been reported for other climate sensitive diseases, the effectiveness of interventions can be context specific. Therefore, it has been suggested that the value of interventions should be investigated by analysing confounding factors (such as level of disadvantage, the social, political and economic context, different types of intervention such as advice, provision, social marketing, economic intervention, self-efficacy training, feedback, email reminders, and duration or sustainability) using multi-regression analyses. Furthermore, observational studies can assist the evaluation process.

It has been pointed out that heat stress related disorders can be managed by oneself, therefore, communication and behavioural change are extremely important. However, information and awareness campaigns should include

not only persons at risk but also their direct relations such as family members, caretakers, neighbours and evidently health professionals. These players can support and encourage adoption of protective measures by those most at risk and should be informed/ trained to detect heat stress symptoms and perform first aid and cooling measures.

Additional interventions that are not related to the public health sector but could contribute to efficient management and adaptation to heat waves are infrastructure and long term planning supporting improved housing quality, community building and green spaces, in addition to reducing personal and institutional carbon footprint to mitigate climate change.

In terms of developing combative strategies and in the face of little evidence, priority should be given to measures that are cheap or address other societal issues. For example there may be little evidence on the effectiveness of trees as a mitigation measure against heat waves. However, they address other societal issues such as biodiversity and improving the urban environment so would be a good initial control measure.

Evaluation of public health interventions is difficult in the context of heat waves. Evaluation of effectiveness can relate to the intervention process, which is relatively easy or to the intervention outcomes, which is more complex. From a systematic review perspective, control groups (other than historical controls) are extremely difficult to define for heat stress studies and could be ethically unfeasible. This type of control group has been shown to overestimate the effectiveness of vector-borne disease interventions. The way forward should include a clear definition of the intervention aims and most importantly intervention outcomes, as these will be assessed post intervention to evaluate effectiveness.

Of the three case studies presented (vector-borne, waterborne diseases and heat stress), heat waves are the odd one out in that there are already national heat wave plans in many countries. Examining how these were created would provide much useful background to help the development of interventions for

other health effects. Politics and social science will be crucial to understanding these as it is too simplistic to assume that interventions are solely based on medical evidence.

Systematic reviews and meta-analysis were very much developed around carefully controlled medical studies. Public health may be very different as multiple interventions are often introduced together making attribution almost impossible. Only a small number of possible public health interventions can probably be examined using systematic reviews. It is important to not ignore other public health interventions.

5. Conclusions

1) For many climate sensitive diseases, we do not have good evidence partly because climate change is moving the goalposts and so we are planning for an unusual situation.
2) The primary literature on disease prevention for some of the most likely impacts of climate change (floods, droughts) is very limited.
3) It is imperative that when adverse climate events and outbreaks happen in the future, lessons are adequately learnt and disseminated.
4) There is an urgent need for further research to evaluate the effectiveness of public health interventions to reduce disease burden for climate sensitive diseases.
5) More effective adaptation strategies are needed in the health sector and elsewhere to combat climate change.

Annexe 1: workshop agenda

	Presenters	
16th June		
14:00 – 14:30	Johan Giesecke, (ECDC)	Welcome and Introductions
14:30 – 15:00	Lee Hooper	Evidence based public health: Evidential quality and the role of the Systematic Review
15:00 – 15:20	Elisabet Lindgren	Presentation: Vector borne disease risks and climate change
15:20 – 15:40	Franziska Matthies	European Framework for Action on climate change
15:40 – 16:00	Paul R Hunter	Presentation: Overview of systematic reviews on the prevention of vector-borne diseases
16:00 – 16:15		Coffee
16:15 – 17:30	Elisabet Lindgren	Breakout session 1: Prevention of vector-borne diseases
17:30 – 18:00		Feedback on breakout session 1
20:00 – 23:00		Social dinner
17th June		
09:00 – 09:20	Stefi Barna	Presentation: A doctor's role in climate change mitigation for health
09-20 – 9:30		Discussion
09:30 – 09:50	Franziska Matthies	Presentation: Heat stress and heat related mortality
09:50 – 10:10	Maha Bouzid	Presentation: Overview of systematic reviews on the prevention of heat stress related mortality
10:10 – 10:30		Coffee
10:30 – 12:30	Franziska Matthies	Breakout session 2: Prevention of heat stress related mortality
12:30 – 13:00		Feedback on breakout session 2
13:00 – 14:00		LUNCH
14:00 – 14:20	Jan Semenza	Presentation: Waterborne disease risks and climate change
14:20 – 14:40	Paul R Hunter	Presentation: Overview of systematic reviews on the prevention of waterborne disease
14:40 – 15:40	Jan Semenza	Breakout session 2: Prevention of waterborne disease
15:40 – 16:00		Coffee
16:00 – 16:20		Feedback on breakout session 2
16:20 – 17:00		Concluding remarks and the way forward

Annexe 2: List of workshop delegates

Name

Stefi Barna
Maha Bouzid
Laurens Bower
Lorenzo DeSimone
Isabelle Devaux
Guy Hendrickx
Lee Hooper
Christoph Höser
Paul Hunter
Ana Maria de Roda Husman
Per Kulling
Iain Lake
Elisabet Lindgren
Franziska Matthies
Knut Erling Moksnes
Gordon Nichols
Britt Grethe Randem
Jan Semenza
Bertrand Sudre
Jonathan Suk
Luigi Vezzulli