

POINT OF VIEW

Burden of Disease and cost-effectiveness in health planning

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© Dorte Birch. Fishmongers at “Brædtet” in Nuuk, Greenland

This Point of View is based on the analysis of burden of disease due to premature mortality in Greenland 1985 -1998 (located on the International Burden of Disease Network, <http://www.ibdn.net>) and on presentations made at the workshop “The Disease Burden on the Greenlandic Society” at the Greenlandic NunaMed 2000 conference on public health in Nuuk, Greenland, September 2000. The views expressed are solely the views of the author.

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By Lasse Chr. Nielsen

Introduction

In order to address the burden of disease in populations, decision makers need the best available evidence. If we are ever to arrive at a future scenario of maximum health gain from available resources, then a step by step strategic approach to identify the control priorities is recommended:

1. Quantify the burden of disease and injury as well as its causes in terms of risk factors and broader health determinants using the best available methods;
2. Identify health inequalities by examining differences in the burden of disease by age, sex, area of residence and socio-economic status;
3. Calculate likely disease burden in the future;
4. Assess the available evidence for various types of health interventions;
5. Combine knowledge regarding the extent of current and future health problems with knowledge regarding ability of health services and multi-sectoral interventions to respond to these health challenges;
6. Apply cost-effectiveness analysis of current and potential new health interventions in order to determine the most efficient combination of relevant health interventions (health packages) in relation to the available resources.

The approach of combined usage is a powerful tool when used to inform decision making at all levels in society. This Point of View recommends the application of the approach to define control priorities and essential packages of care in the light of experience gained by practical application in the health care sector in Greenland.

The Global Burden of Disease project and the DALY

The WHO and the World Bank launched the The Global Burden of Disease (GBD) 1990 project in order to apply the approach on an international scale (Murray&Lopez 1996, WB 1993). As well as generating the most comprehensive and consistent set of estimates of mortality and morbidity by age, sex and region ever produced, the GBD 1990 also introduced a new metric – Disability Adjusted Life Year (DALY) – to quantify the burden of disease.

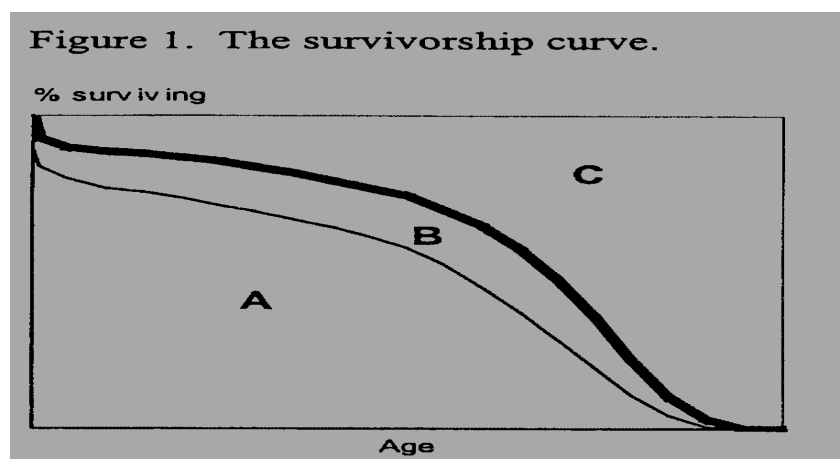
The DALY is a *health gap* measure, which combines information on the impact of

1. Premature death
2. Disability and other non-fatal health outcomes.

One DALY represents one lost year of ‘healthy’ life and the burden of disease of a given population as a measurement of the gap between current health status and an ideal situation where everyone lives into old age free of disease and disability.

The DALY expresses, in a single metric, the life years in perfect health lost to any community from both premature death and from living with a disability of specified severity and duration. Technically the Disability Adjusted Life Year therefore consists of two components:

DALY = YLL + YLD, where **YLL** = **Y**ears of **L**ife **L**ost and **YLD** = **Y**ears **L**ived with **D**isability



Source: WHO

In figure 1, the bold line is the survivorship curve from a hypothetical life table population. The thin curve under B is a hypothetical curve of survivors to each age x in optimal health. Area A represents time lived free of disability, area B, time lived with disability, and area C represents time lost due to mortality. All the variants of years lost measure the gap in years between age at death and some arbitrary decided upper age limit (typically 65 or 75 years), and they are examples of *mortality gaps*, or the area labelled C in figure 1.

The Burden of Disease approach using DALYs was first applied in the World Bank Report 1993 “Investing in health” and later in several WHO publications, e.g. World Health Report 1999, 2000 and 2001. The approach has also been applied in several national and regional studies and it is therefore also applicable to smaller populations and national sub-populations, e.g. the populations of Greenland, Victoria (Australia) and Stockholm (Sweden)¹.

By using the same unit (DALYs) to measure disease burden, comparative analysis can be applied not only between different populations but also to the comparison of cost-effectiveness of competing intervention types, thereby providing essential information for planning and prioritisation purposes when addressing the specific disease burden profile of the population in question.

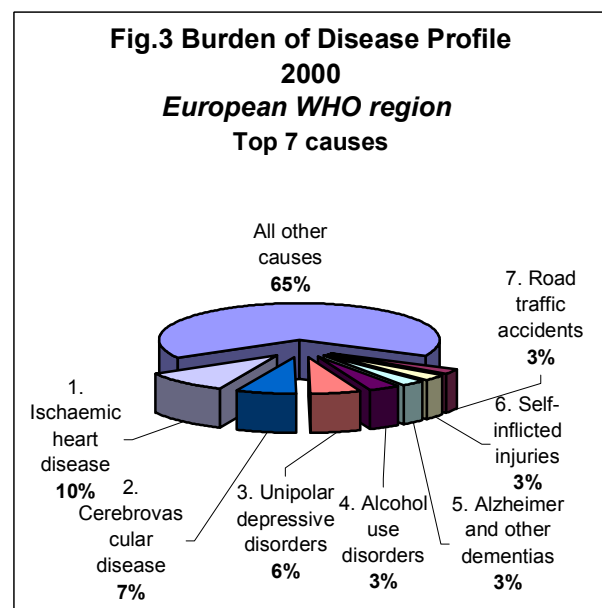
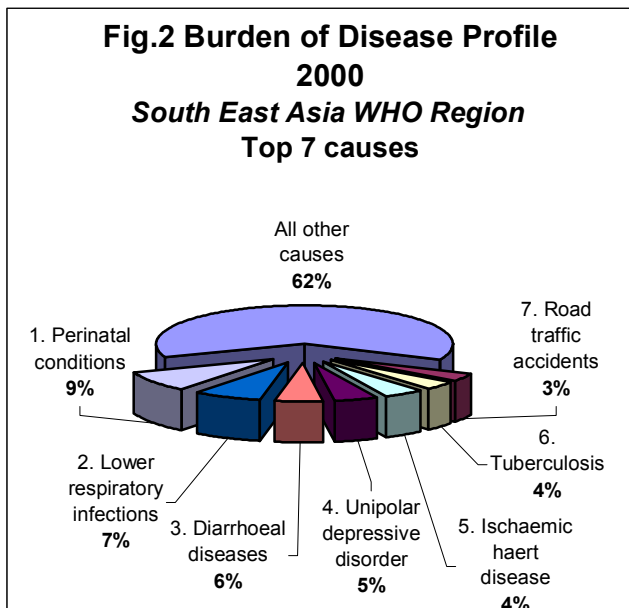
The WHO-launched Burden of Disease methodological approach aims to:

- (i) Dissociate epidemiological assessment of the magnitude of health problems from advocacy by interest groups of particular health policies or interventions;
- (ii) Include in health policy debates information on non-fatal health outcomes along with information on mortality;
- (iii) Undertake the quantification of health problems in time-based units that can also be used in economic appraisal, thereby supporting objective (i).

These three goals articulated for the GBD 1990 also remain central to the GBD 2000 project.
(Source: GBD 2000)

¹ See home page of the International Burden of Disease Network (IBDN) on <http://www.ibdn.net>

The World Health Organization is now undertaking a new assessment of the Global Burden of Disease (GBD) for the year 2000 (GBD 2000).



Source: WHO, EIP Discussion paper 36, 2000.

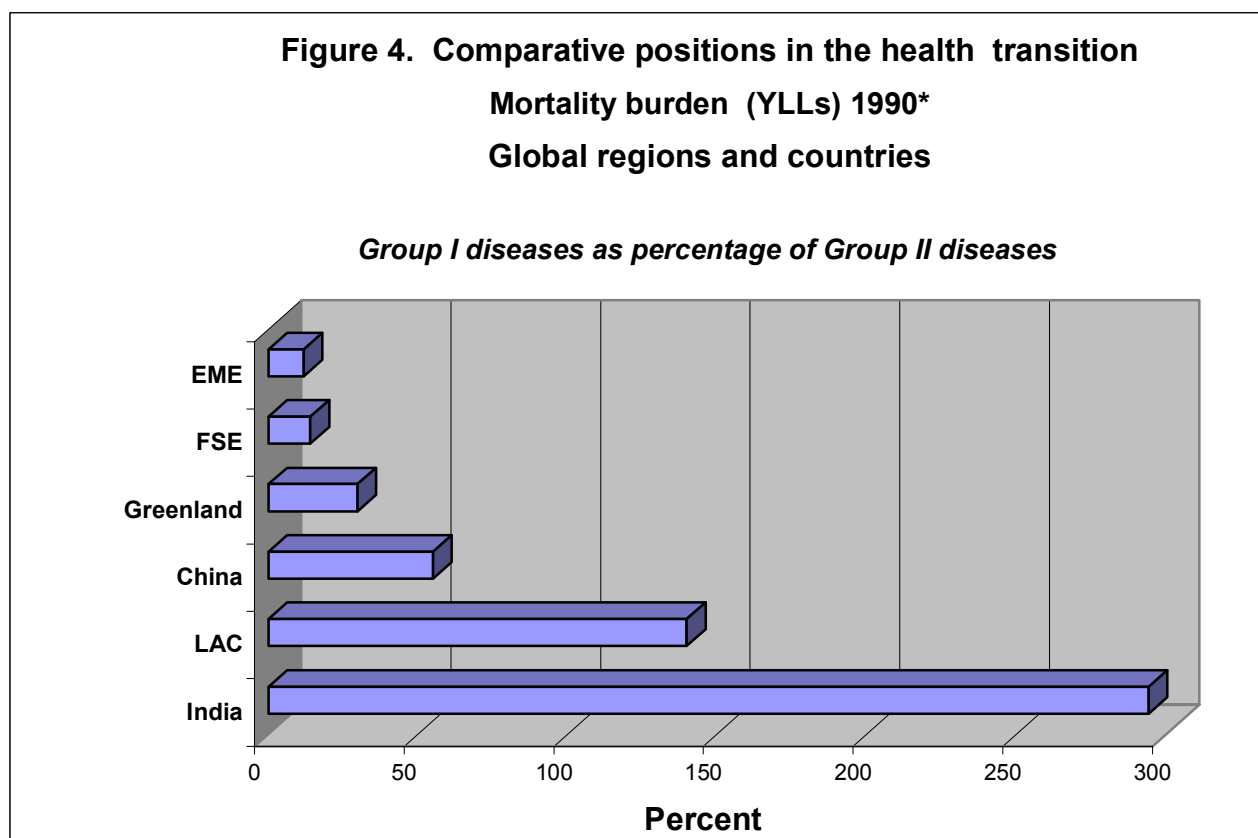
Figures 2 and 3 show the Burden of Disease profiles for two continental WHO regions, South East Asia versus Europe (GBOD 2000). In South East Asia (figure 2) the three leading causes of DALYs lost in 2000 comprises nearly one fourth of total disease burden: Perinatal conditions (9%), lower respiratory infections (7%) and diarrhoeal diseases (6%), and these diseases and conditions are all considered *avoidable*. In Europe the three leading causes of DALYs lost were ischaemic heart disease (10%), cerebrovascular disease (7%) and unipolar depression (6%) all of which comprise 22% of total disease burden. Characteristically, the burden of disease profile for the European population is dominated by non-communicable diseases due to the region's relatively high position in the *epidemiological transition* process and to life style factors related to high- and middle-income countries. Furthermore, these diseases are considered partly amenable to preventive interventions implying both a high degree of care and high percentage of hospital capacity, measured, for example, in days of bed occupancy.

To summarize, the burden of disease profiles for South East Asia and Europe are due to their relative positions in the epidemiological transition process implying different strategies and prioritisations according to curative and preventive interventions as well as the implications for the respective *burden of care* set-up. The various profiles of the disease burden therefore imply different health intervention and care strategies and prioritisations of the deviated *resource burden*. In order to bring down the disease burden and raise the population health status for the populations in the two continents, the relative cost-effectiveness of preventive and curative interventions therefore becomes essential in relation to managing the implied resource burden. Perinatal conditions, lower respiratory conditions and diarrhoeal diseases cause about 25% of all DALYs lost in South East Asia; cost-effective strategies addressing these diseases will increase population health significantly.

Preventive interventions in Europe addressing risk factors related to life style will be beneficial to population health. In particular, reductions in levels of per capita tobacco and alcohol consumption in connection with interventions lowering the prevalence of obesity will reduce the burden of cardio-vascular diseases in European populations.

The health transition and predictions of Burden of Disease

In order to optimise the ability of health services and multi-sectoral responses to meet the challenges of national health problems, it is vital to establish the positions held by regions and countries in the epidemiological transition, not least when it comes to *long term planning* (GBOD 2000). Respective positions in the health transition process are shown in figure 4 below.



Notes: *Greenland: Average 1988 - 1992

Abbreviations:

1. The WHO Burden of Disease classification groups all diseases and injuries into three groups: **Group I** consists of *communicable diseases, maternal causes, conditions arising in the perinatal period and nutritional diseases*, **Group II** is *all the non-communicable diseases* while **Group III** comprises *all injuries* (intentional and unintentional).

2. EME=Established Market Economies, FSE= Former Socialist Economies, LAC= Latin America and the Caribbean.

Source: Nielsen et al (2002) and Murray & Lopez (1996)

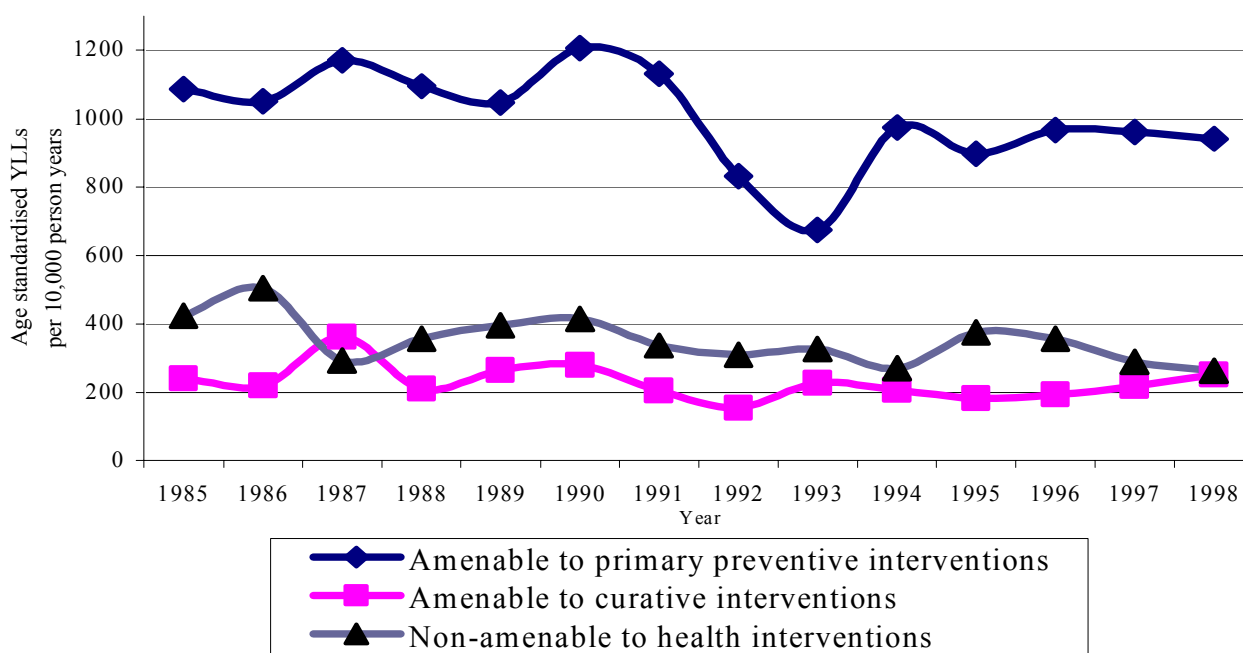
Established market economies (EME) are characterised by occupying the longest established position in the health transition: Group I diseases comprise only 12% of Group II diseases, the most dominant group of causes in EME. India, on the other hand, is characterised by a disease burden from Group I three times the size of Group II, indicating priorities and approaches that differ from those of EME, FSE and Greenland. The latter countries nevertheless represent a potential *predictor* for the process direction of the health transition in India in terms of long term planning, as is indicated by the relative position of China (see figure 4). In the process of global health transition

the less developed parts of the world can therefore expect to move towards the position of the developed countries as a result of economic development and ageing of populations.

Burden of Disease and ex-post evaluation of health system response on macro level

The burden of disease approach can also be used for ex-post evaluations of various health campaigns and interventions, as well as health system performance on aggregate level. In Greenland extremely high taxation was legislated for alcoholic beverages in the 1980s in order to lower the excessive consumption rate. In 1987 alcohol consumption reached a peak of 22 litres per person (>14 years), one of the highest global levels ever for any population. The Ministry of Health in Greenland applied burden of mortality to evaluate the potential effect of the various initiatives and campaigns on the Greenlandic population comprising app. 55,000 inhabitants (Nielsen et al 2001). Figure 5 shows the development of the disease burden due to premature mortality for Greenlandic males (measured by Years of Life Lost (YLLs), where 1 YLL equals 1 DALY from premature death in the period 1985 – 1998. Total mortality burden is grouped into three cause categories: (1) Diseases amenable to primary prevention; (2) diseases amenable to curative interventions; and (3) diseases non-amenable to health interventions.

Figure 5. Trends in mortality burden 1985–1998 for men grouped into potential intervention areas. Number of standardised YLLs/DALYs per 10,000 person years, males, Greenland.



Source: Nielsen et al. 2000, IBDN, <http://www.ibdn.net>

As can be seen from figure 5, more than 50% of the total Greenlandic mortality burden for men was amenable to primary preventive interventions in the period 1985 -1998. Figure 5 also shows that, from 1990 and onwards, a substantial decrease in the level of the mortality burden amenable to primary prevention took place. This year marked the onset of a comprehensive intervention strategy with introduction of new legislation on alcohol sales followed by progressive taxation on alcoholic beverages according to alcohol volume. In the period following the onset of the various anti-alcohol consumption interventions, the disease burden amenable to primary prevention for males decreased

by 20% on average from average 1985-1991 to average 1992-1998. From 1987 to 1992 total alcohol consumption in Greenland decreased from 22 litres per person (1987) to a relatively stable level of 13 litres of alcohol on average per person in 1992-1998. One in five years of life lost from the preventable disease burden was gained in the Greenlandic male population following the comprehensive anti-alcohol intervention strategy initiated in the early nineties by the Greenlandic Home Rule Government.

Surveillance of health system performance on a macro level is therefore another potential usage of disease burden, recommended and applied by the WHO (WHR 2000). As can be seen in figure 5, diseases amenable to curative interventions have only a minor share of total years of life lost while the preventable disease burden is by far the largest component of the disease burden. Only 40 years ago the situation was the inverse: curative diseases, and especially infectious diseases such as tuberculosis, comprised by far the largest share of the total disease burden in Greenland.

By means of a comprehensive multi-sectoral strategy, combining intensive curative and preventive efforts, the disease burden of tuberculosis was brought down to the controlled levels now prevailing in Greenland. The present substantial increases in population health would imply that a multi-sectoral approach, with a focus on risk factors such as alcohol and tobacco, has effectively reduced the prevailing preventive disease burden in Greenland.

Cost-effectiveness and health packages

To ensure that any new resources allocated to health interventions have the maximum possible effect on the population health, cost-effectiveness should be considered in the design of strategies for cure, prevention, care and support. The managerial capacity of the Ministry of Health is such that it cannot devote its scarce resources to every cost-effective intervention that if implemented may significantly improve population health. The list of top priorities for government attention should be based on specific criteria's and can be called a list of National Control Priorities. One such criteria should be:

Interventions that cost less than x dollars per DALY averted. X will depend on the income per capita of the country undertaking the analysis.

An important step in designing health *intervention packages* is to investigate the cost per DALY (or other health indicators) gained by various relevant health intervention types. Often this first step implies reviews and assessments of cost-effectiveness analysis made previously. These analysis should preferably be conducted as close as possible to the population and environment in which implementation of the respective interventions is intended.

In the hypothetical examples given in tables 2 and 3, two different health packages, A versus B, are presented, both aimed at lowering the Greenlandic disease burden related to the risk factors of tobacco and alcohol. The two health packages have a similar cost level of US\$ 500,000 but comprise different combinations of preventive and curative interventions. The two benefit packages have different weights of the interventions included. Health package type A is characterized by a dominance of *preventive interventions*: 70% share of public health services and 30% of clinical services (see table 2). According to this package, the interventions combined will gain a total of 4,300 DALYs averted (equivalent to 147,2 lives saved) for US\$ 500,000. Health package type B, with a 50/50 percent combination of public health/clinical interventions, will gain a total of 2,850 DALYs equivalent to 97,6 lives saved (see table 3).

The choice of the right combination of intervention types is important in order to gain maximum health gains from a fixed limit of available resources, in this case, US\$ 500,000. Package A gains 1,450 DALYs *more* than package B, a health gain equivalent to 49.6 lives saved. Judged by the criteria of *value for money*, package A is therefore superior to package B when measured in health gain.

Table 2. Health package, *Type A*: 70% prevention and 30% cure. Cost: US\$ 500,000

<i>Intervention-type</i>	<i>Share (% of total cost)</i>	<i>CE Factor²</i>	<i>DALYs gained / lives saved</i>
Health education in primary schools	30%	50	3,000/102.7
TV /radio spots with VIP persons ³	10%	125	400/13.7
Decentralising administration of alcohol sales	10%	167	300/10.3
Taxation on alcohol beverages and tobacco	20%	333	300/10,3
X clinical intervention scheme	20%	500	200/6.8
Y clinical intervention scheme	10%	500	100/3.4
Total DALY's gained /lives saved	100%		4,300/147.2

Source: hypothetical example based on scientific research analysis and evaluations on the subjects.

Table 3, Health package, *Type B*: 50% prevention and 50% cure. Cost: US\$ 500,000.

<i>Intervention-type</i>	<i>Share (% of total cost)</i>	<i>CE Factor²</i>	<i>DALYs gained/ lives saved</i>
Health education in primary schools	10%	50	1,000 / 34.2
TV /radio spots with VIP persons ³	30%	125	1,200 / 41.1
Decentralising administration of alcohol sales	0%	167	0/0
Taxation on alcohol beverages and tobacco	10%	333	150 / 5.1
X clinical intervention scheme	30%	500	300 / 10.3
Y clinical intervention scheme	20%	500	200 / 6.8
Total DALY's gained/lives saved	100%		2,850 / 97.6

Source: hypothetical example based on scientific research analysis and evaluations on the subjects.

When defining a health package, other factors besides the peer question of cost-effectiveness should also be taken into account. Factors such as *feasibility*, *potential cultural barriers* of implementing interventions and *equity* ought to be considered in parallel to the economic efficiency of the various intervention types. When selecting the most efficient combination of interventions, the importance of the following factors often becomes apparent:

- technical feasibility;
- local culture and power balances;
- local life style and habits;

² “CE factor” indicates dollars per DALY averted. In this example these factors are arbitrary guesstimates based on several research analysis and evaluations indicating different relative cost-effectiveness of the interventions suggested.

³ The fact that several highly positioned Greenlandic politicians publicly declared that they suffered from alcohol abuse and was seeking treatment, e.g. by the Minnesota cure, is seen as a potential explanatory factor of the reduction in alcohol consumption in Greenland in the early 1990's. This open attitude from VIPs in the Greenlandic society lowered stigmatization on both individual and societal level in relation to alcohol abuse and thereby paved the way for acknowledgement and public help of implied problems on all levels.

- equity considerations;
- economic impact assessments of the disease burden on society;

In the hypothetical example given above—decentralising administration of alcohol sales from central government to local government—certain prevailing local conditions should be taken into account such as: local commitment to and understanding of the necessity of reducing alcohol consumption by restrictions on sales, for example, to young adults and to people already under the influence of alcohol (Berman 2000). In some cases local commitment and willingness to reduce problems will prove a prerequisite for a successful intervention strategy, irrespective of whether the restrictions are set by a central or a local government. When considering curative interventions with increased technical preconditions, thought should be given beforehand to their feasibility and to potential impediments if successful implementation is to be ensured.

Summarising: Potential uses of burden of disease approaches

As shown in the above examples, the burden of disease functions in five major ways to underpin health policy:

- *Assessing performance*
In the same way that Gross Domestic Product (GDP) is a measure of economic performance the Burden of Disease is a measure of the relative performance of the health care sector and of the effect of primary and secondary interventions *per se*. In addition to this feature, application of the Burden of Disease approach opens for international comparisons.
- *Identifying national control priorities*
Many countries now identify a relatively short list of interventions, the full implementation of which becomes a specific priority requiring national political and administrative attention. Because political attention and administrative capacity are in relatively fixed and short supply, the benefits from using those resources will be maximised if they are directed to interventions that are both cost-effective and aimed at problems associated with a high burden. Thus, national assessments of disease burden are instrumental in establishing this short list of control priorities.
- *Allocating research and development resources*
Estimates of disease burden become essential for formulation of policy whenever an activity is required to show results proportional to the size of the problem being addressed rather than to the scale of the activity. Such is the case with political attention and with time in the medical school curriculum; and it is likewise true for the allocation of research and development resources. Improving research and development policy in health may show up be more important than other – at first sight - direct intervention types.
- *Allocating resources across health interventions*
Here disease burden often plays only a minor role; in cost-effectiveness terms, the task is to shift resources to interventions which will generate the greatest reduction in disease burden, measured as lost Disability Adjusted Life Years (DALYs). When there are major fixed costs in mounting an intervention—as is the case with political and managerial attention to national control priorities—burden estimates are indeed required to optimise resource allocation. However, much progress can generally be made merely by understanding how the DALYs gained from an intervention vary with the level of expenditure on it; such assessment is the stuff of cost-effectiveness analysis. The DALY, as a common measure of

effectiveness, allows comparison of cost-effectiveness across interventions addressing all conditions.

- *Generating a forum for informed debate of values and priorities*

The assessment of disease burden, in a country-specific context, in practise involves participation of a broad range of national disease specialists, epidemiologists and, often, policy makers. Discussion of the inter-relatedness of diseases and their risk factors in the light of local conditions clarifies the establishment of priorities. The preparation of a well-defined product generates a process which is valuable in its own right.

Important links and key references:

Berman M, Hull T, May P. *Do Alaska Natives Communities That Control Alcohol Have Fewer Violent Deaths?* Journal of Alcohol Studies, March 2000 and University of Alaska Anchorage, Institute of Social and Economic Research, Alcohol Control Research 2000, <http://www.iser.uaa.alaska.edu/Home/ResearchAreas/AlcoholControlResearch.htm> .

(GBD 2000) Global Burden of Disease 2000 Project in Aging Populations, Harvard University. <http://www.hsph.harvard.edu/burdenofdisease/index.htm>

IBDN, International Burden of Disease Network, <http://www.ibdn.net>

Nielsen, LC, Hansen KS, Nielsen UR. *Mortality in Greenland during the period 1985-1998. Trends in mortality in the Greenlandic population using two different.* Paper to the International Burden of Disease Network (IBDN). 2000. Available on <http://www.ibdn.net>, click on “Countries”.

Nielsen, LC, Hansen KS, Nielsen UR. *Using Burden of Disease to Define National Control Priorities in the Greenlandic Health Care Sector.* Paper presented on the workshop “Disease Burden of the Greenlandic Society” at the Nuna Med 2000 Conference, Nuuk (Greenland), September 2000. Available in Conference Report “*Nuna Med 2000 – A Greenlandic Conference on Health*”, Copenhagen 2002.

Peterson S, Diderichsen F, Backlund I. *Sjukdomsbördan I Stockholms Län – en regional DALY kalkyl.* Stocholms läns landsting, Socialmedicin. Karolinska Sjukhuset. 1999.

World Health Organization, Various EIP discussion papers from “*Discussion Papers Cluster on Evidence and Information for Health Policy*”, see http://www3.who.int/whosis/discussion_papers/discussion_papers.cfm?path=whosis_discussion_papers&language=english

World Health Reports 1999, 2000 and 2001. WHO Geneva. See <http://www.who.int/whr/2001/archives/index.htm>