

Global Burden of Infectious Diseases.

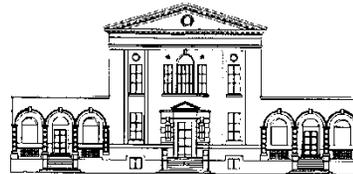
Not just numbers!

SIXTH WORLD CONFERENCE ON
THE FUTURE OF SCIENCE™



Viruses: the invisible enemy

VENICE, SEPTEMBER 19-21, 2010



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**WHO Collaborating Center for clinical care, diagnosis, response and training on
Highly Infectious Diseases**

What is burden?

- Burden is load on individual or family or society or Nation or the globe
- It could be cultural, pathological, economic, political, social or socioeconomic



Infectious Diseases

- Nearly 2,000 different microbes cause diseases
- 10 B new infections/year worldwide
- 13 M deaths from infections/year worldwide

Burden of Disease

“...the gap between a population’s health status and some reference standard...”

Murray 1996

What is burden?

- Disease burden is judged against single disease/condition
- Disease investigator needs to understand variety of burdens



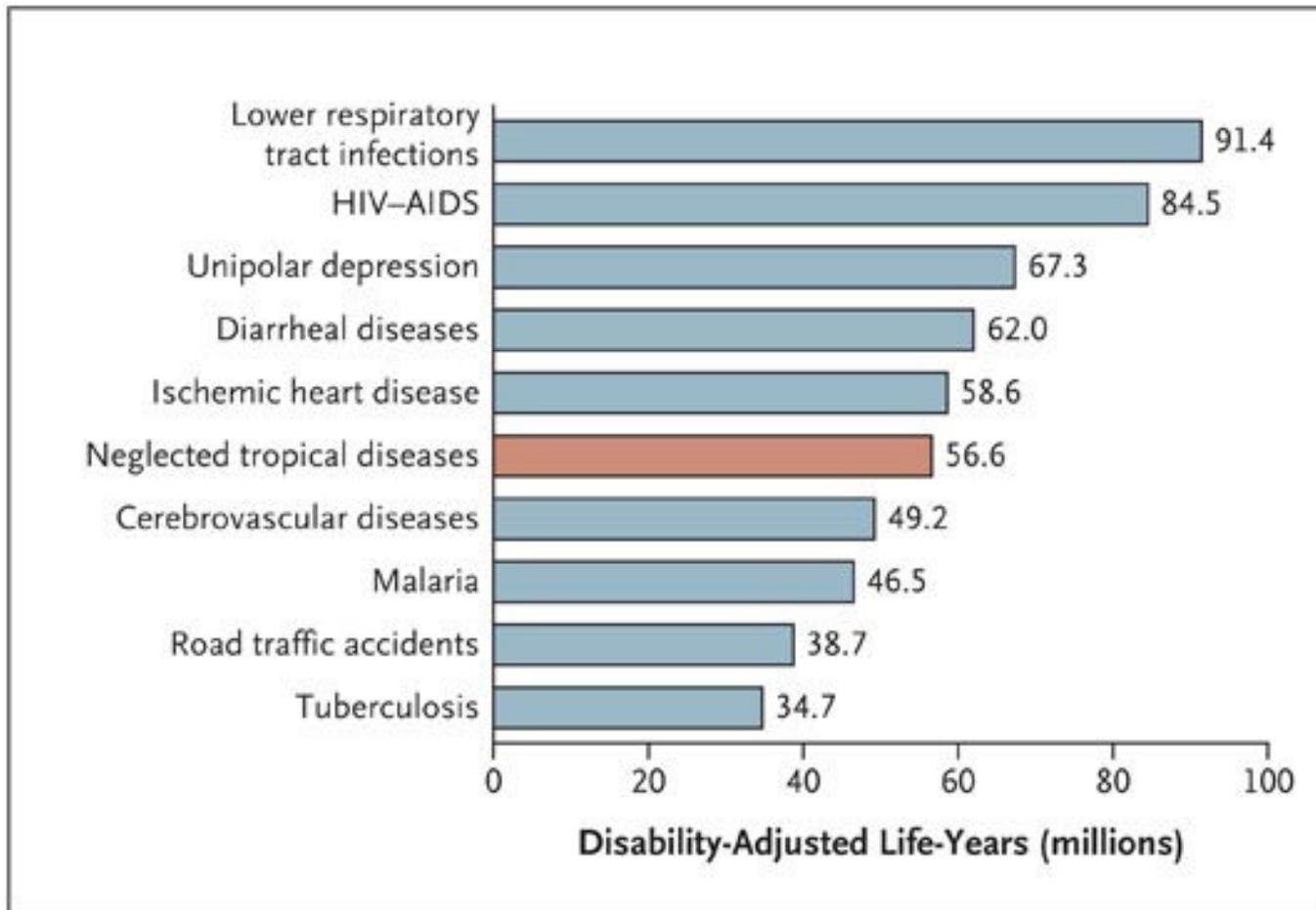
**How many people are sick at any
given time, at any place?**

Infectious Diseases, 2010

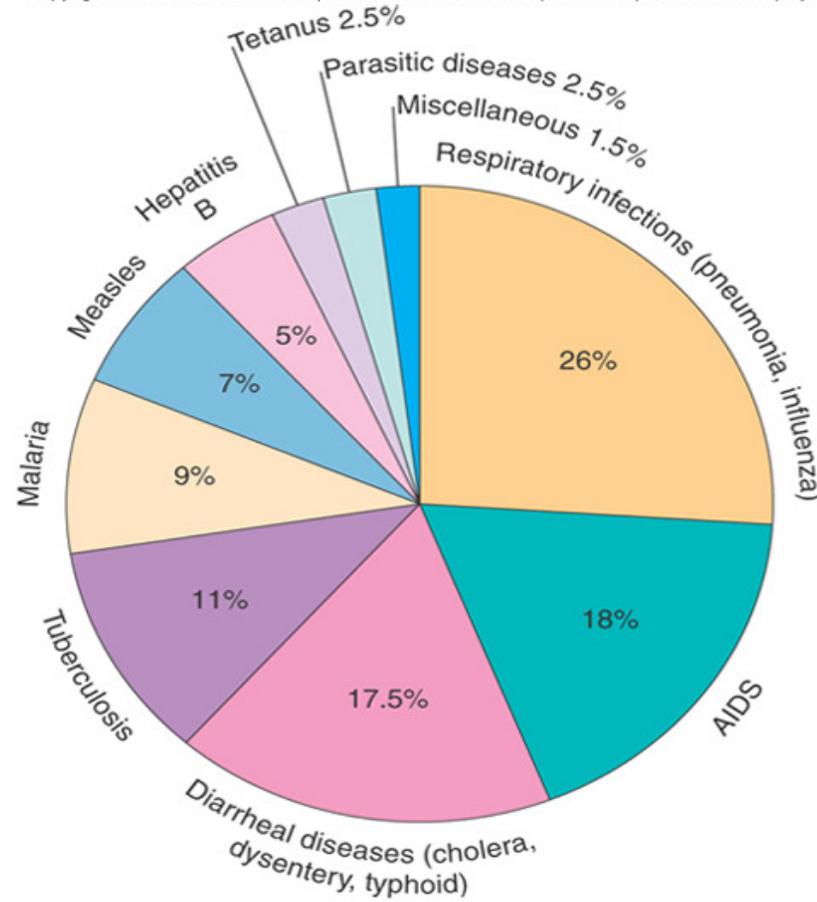
- ~ 50,000 deaths each day in the world.
- ~ 17 million annual deaths
- responsible for ~ 33% of all deaths in the world (circulatory diseases for 29% and cancer for 12%)
- dozens of new infectious diseases have been discovered in the last 30 years (2/3 have been zoonoses)

Importance of Communicable Diseases

- Significant burden of disease especially, **but not only**, in low and middle income countries
- Social impact
- Economic impact
- Potential for rapid spread
- Human security concerns
 - Intentional use



Hotez P et al. NEJM 2007;357:1018-1027



Worldwide infectious disease statistics

Depicts the 10 most common infectious causes of disease

Leading Causes of Infectious Disease Deaths Worldwide

| <u>Disease</u> | <u>Est. Deaths per Year</u> |
|---|------------------------------------|
| Lower respiratory tract infections | ~4.2 million |
| Diarrheal diseases | ~2.2 million |
| HIV/AIDS | ~2.0 million |
| Tuberculosis | ~1.5 million |
| Hepatitis viruses | ~1 million |
| Hepatitis B virus | ~620,000 |
| Hepatitis C virus | ~366,000 |
| Malaria | ~900,000 |
| Pertussis | ~295,000 |
| Neonatal tetanus | ~213,000 |
| Measles | ~197,000 |

2010: the year of the new Global Burden of Diseases, Injuries, and Risk Factors Study (the GBD 2005 Study)

- Phase 3: January 1, 2010 – November 30, 2010 the project will produce a final set of estimates
- commenced in the spring of 2007
- it is the first major effort since the GBD 1990 Study to carry out a complete systematic assessment of the data on all diseases (483 sequelae of 109 major causes of death and disability) and injuries, and produce comprehensive and comparable estimates of the burden of diseases, injuries and risk factors for two time periods, 1990 and 2005, disaggregated by eight geographic regions.

How to Measure or Determine the Burden

- Appropriate tools
- Surveillance data
- Disease trends
- Studies and investigations



Problems with the Measurement Methods

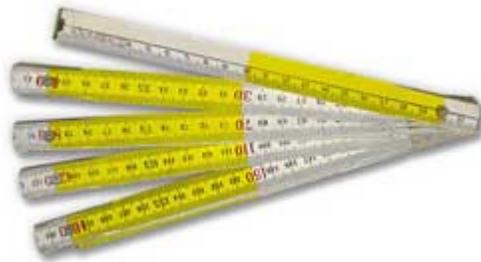
- No baseline or poor baseline data
- Inconsistent data collection over time
- Epidemiological and lab methods not consistent
- Difference in clinical capabilities and level of infrastructures
- Surveillance is different between countries and changes over time
- Outcome data were not collected with the idea of answering to a specific question

Determinants of Disease Trends

- Sporadic cases
- Outbreaks
- Special studies and surveillance
- Agent/condition risk factor studies
- Diseases/illness estimates



Are we really comparing
apples to apples ?



=



Persons

- Who has the disease?
 - Male versus female?
 - Young versus older?
 - Ethnic majority versus minority?
 - Rich versus poor?
 - Urban versus rural?



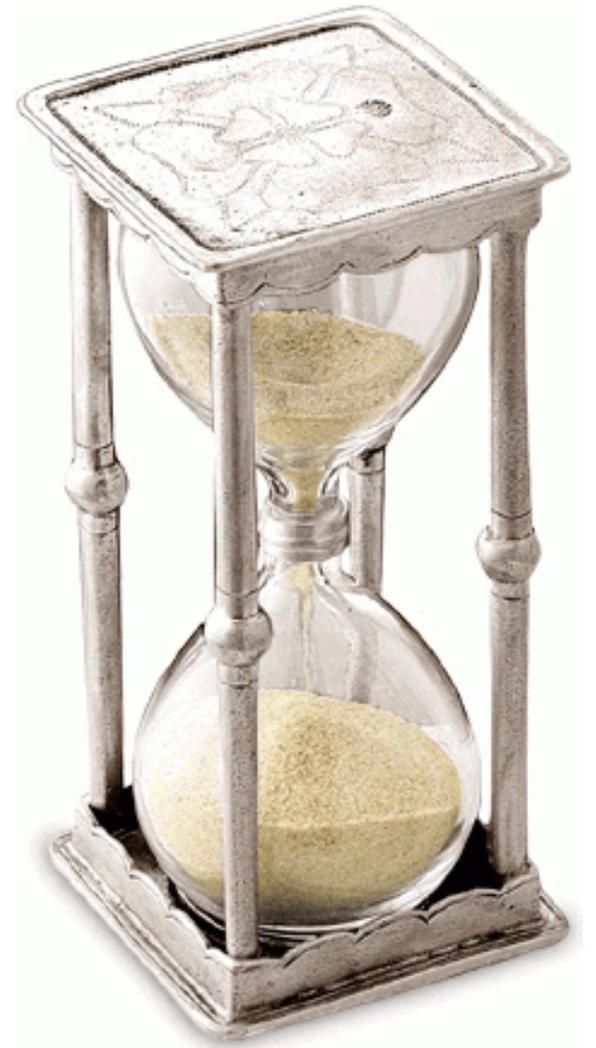
Place



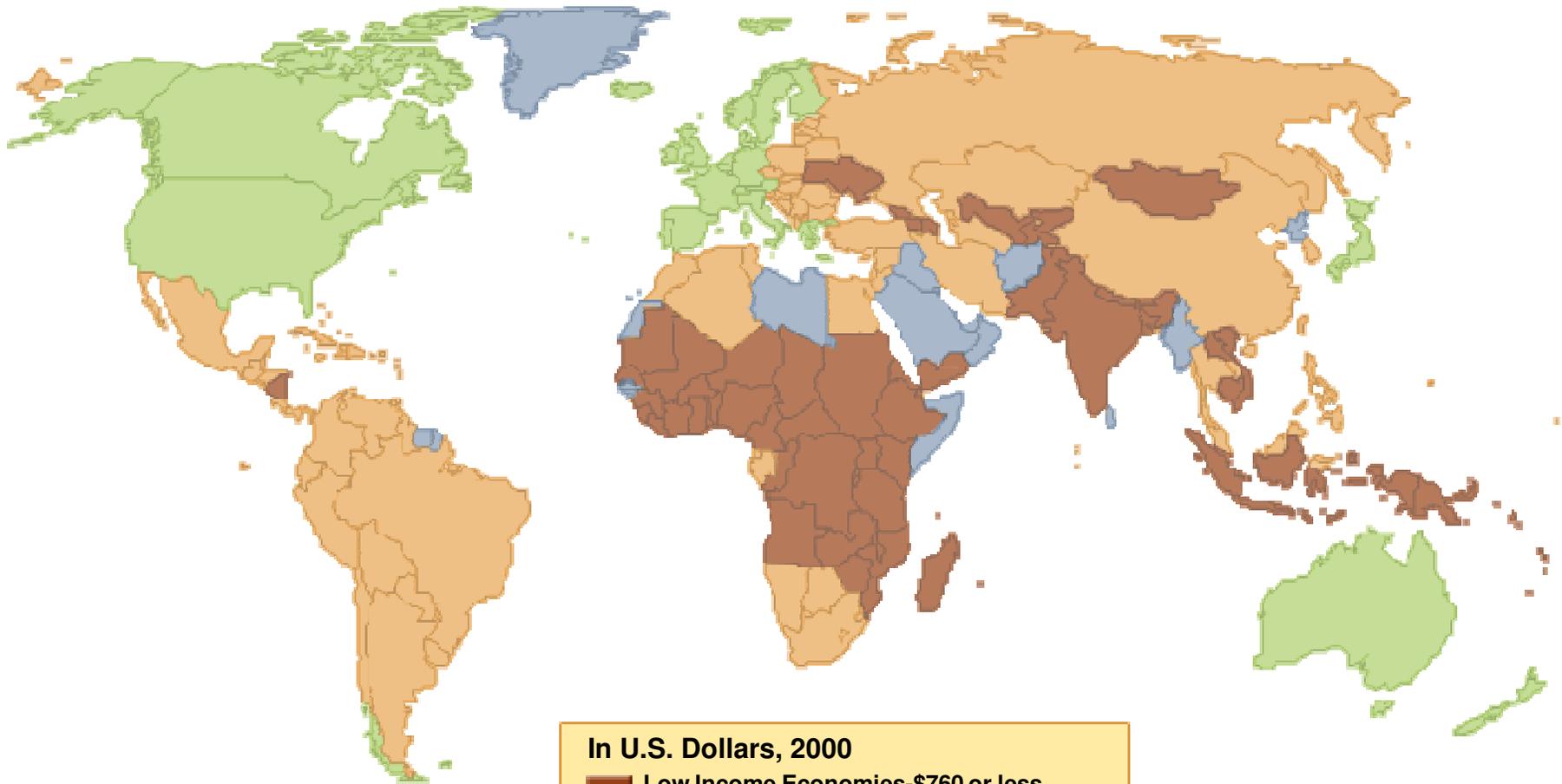
- Where is the disease more or less common?
- Different scales of geography:
 - Regions of earth, countries, states, counties, cities, neighborhoods
- May not include political boundaries
 - Urban/rural, proximity to power lines, chemical plants, etc.

Time

- Is the disease rate changing over time?
- Different scales here, too: decades, seasons, days



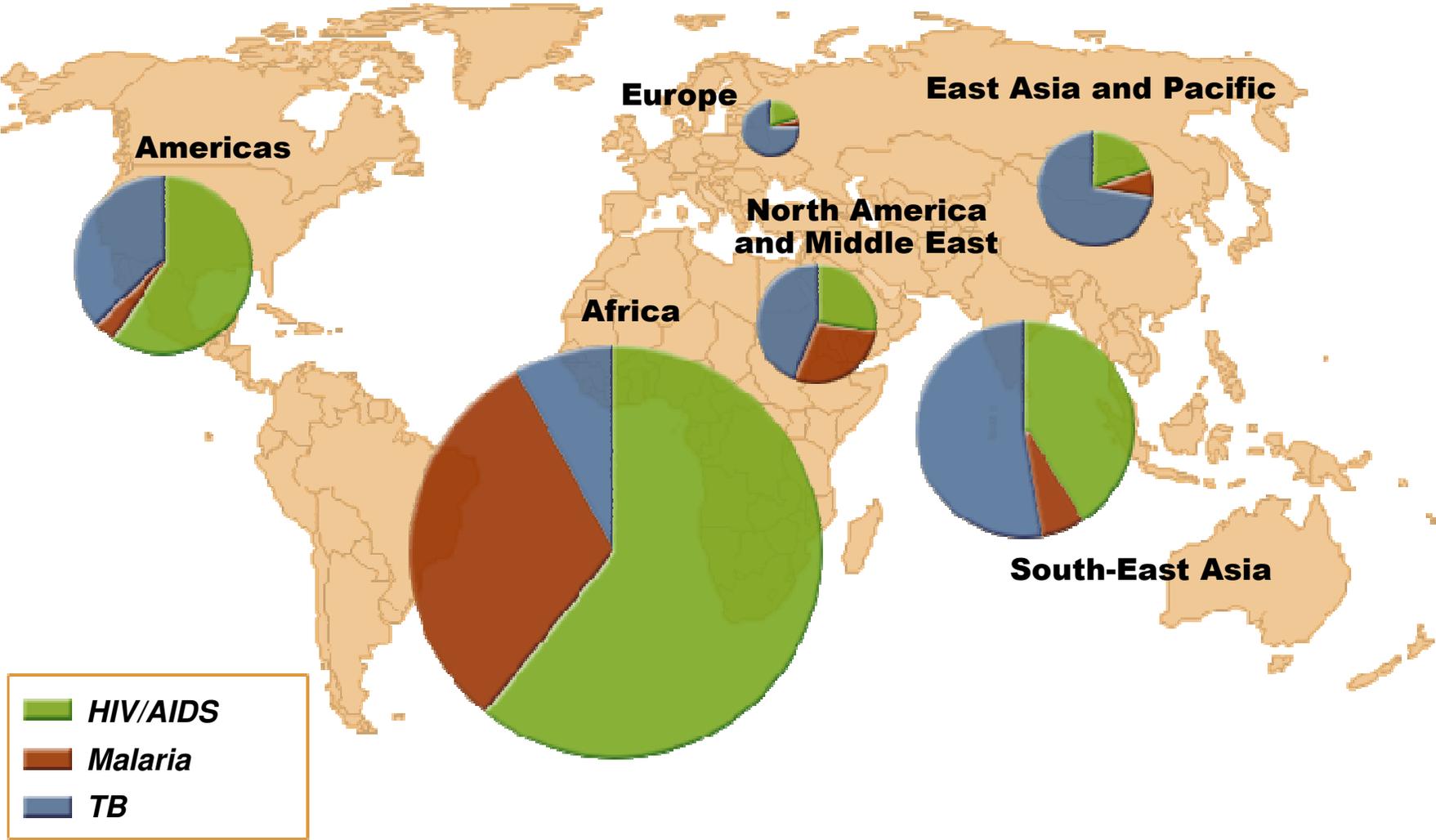
GPN per Capita



In U.S. Dollars, 2000

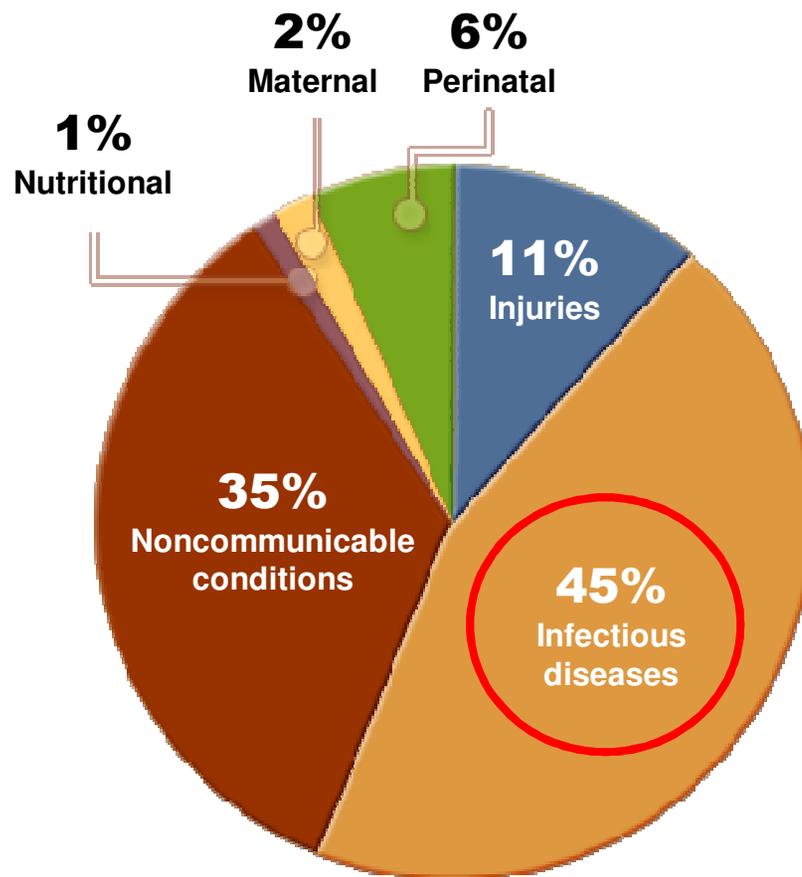
- Low Income Economies-\$760 or less
- Middle Income Economies-\$761-\$9360
- High Income Economies-\$9361 or more
- No Data

HIV/AIDS, Malaria and TB Relative Share of Disease Burden (Lost HLYs) by Region

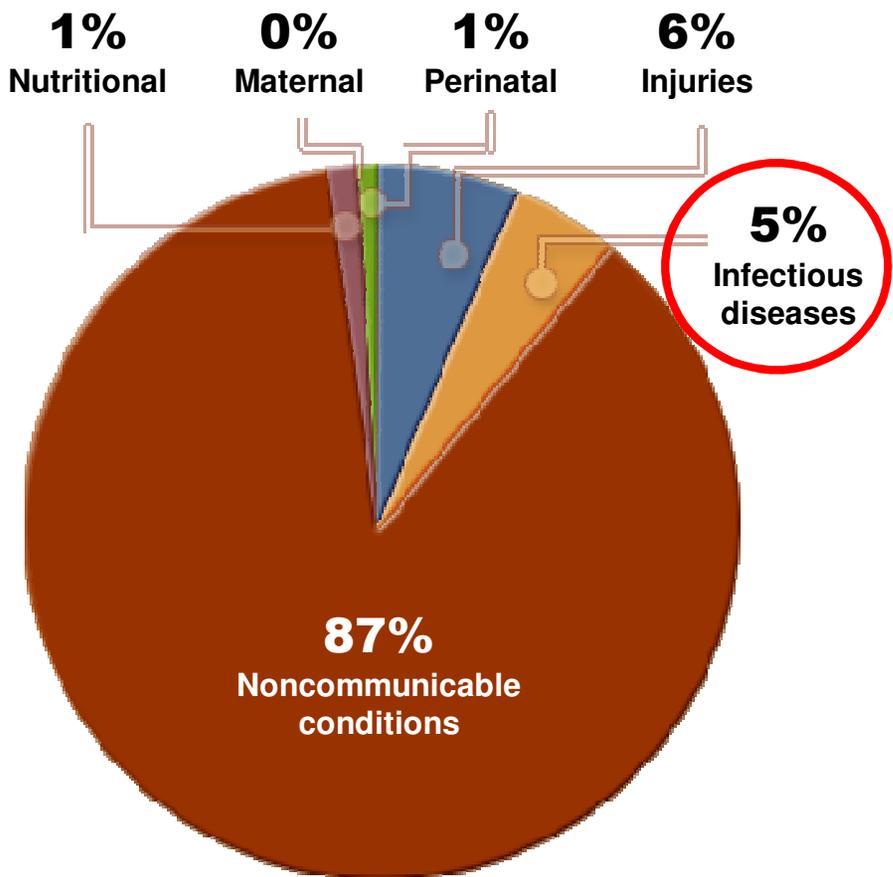


Main Causes of Death

Low-income countries
In South-East Asia and Africa



High-income countries
Primarily in North America and Europe



You might find the need to compare completely unrelated data

The difference is *not* trivial!



It is like comparing apples to oranges



you actually don't want to compare unrelated data so that you don't infer invalid correlations

Comparing apples and oranges

What do we get for a country if we use a similar methodology for another country?



Caravaggio - 1597-1598 Canestra di frutta
Oil on canvas

Disease

- Health is compromised due to diseases
- Diseases lead to death and / or disability
- Quality and quantity of life is reduced due to disease
- Mortality + Disability is proportional to the quantity of disease

Utility of estimating Disease Burden

- Important input to health decision-making and planning processes
- Provides a framework for integrating, validating, analyzing and disseminating information needed to assess the comparative importance of diseases, injuries and risk factors in causing premature death, loss of health and disability in different populations

Global burden of disease 1/3

- **The original GBD (1990 Study) was commissioned by the World Bank in 1991 to provide a comprehensive assessment of the burden of 107 diseases and injuries and ten selected risk factors for the world and eight major regions in 1990**
- **The methods of the GBD 1990 Study created a common metric to estimate the health loss associated with morbidity and mortality**

Global burden of disease 2/3

- **1993- term coined by epidemiologists and economists who were studying international variations in the patterns of disability-adjusted life expectancy for the World Bank**
- **from a collaborative effort initiated in 1992 and is between the Harvard School of Public Health, the World Health Organization and the World Bank**
- **the method of calculation appeared in the World Bank's *World Development Report* for 1993**

Global burden of disease 3/3

- GBD was used as a numerical indicator of the impact of all forms of illness and disability on the expectancy of remaining years of healthy life in the population of a country, or in age- or sex-specific or other segments of the population**
- The global burden of disease is calculated by using nationally available data on life expectancy and on major varieties of disability**
- GBD is therefore a rather insensitive indicator, albeit a very useful one**

Burden of disease

- Unit of measurement for Burden of disease = DALY

DALY means Disability-Adjusted Live Year

- Unit of measurement of benefits from intervention = QALY

QALY means Quality-Adjusted Life years

Global burden of disease

- **Harvard University**
- **Institute for health metrics- Washington University**
- **Johns Hopkins University**
- **University of Queensland**
- **World Health Organization**



World Health Organization

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Health statistics and health information systems

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Global Burden of Disease (GBD)

Global Burden of Disease analysis provides a comprehensive and comparable assessment of mortality and loss of health due to diseases, injuries and risk factors for all regions of the world. The overall burden of disease is assessed using the disability-adjusted life year (DALY), a time-based measure that combines years of life lost due to premature mortality and years of life lost due to time lived in states of less than full health.



The WHO GBD project draws on a wide range of data sources to quantify global and regional effects of diseases, injuries and risk factors on population health. The latest assessment of GBD for 2004 is available, together with updated projections to the year 2030, and documentation of methods and data sources. Manuals, software and other resources are also provided for carrying out burden of disease studies

NEW!!

[World Health Statistics 2010](#)

RECENT PUBLICATIONS AND ARTICLES

[Monitoring and evaluation of health systems strengthening \[pdf 392kb\]](#)

A comprehensive framework and applications developed by WHO, GAVI, Global Fund and World Bank in consultation with partners and countries.

Women and health: today's evidence tomorrow's agenda
9 November 2009 -- WHO, Geneva,

Global burden of disease

The **current** aim of the GBD study is to provide:

- systematic incorporation of information on non-fatal outcomes into the assessment of health status (using a time-based measure of healthy years of life lost due either to premature mortality or to years lived with a disability, weighted by the severity of that disability)
- estimates and projections derived on the basis of objective epidemiological and demographic methods, which were not influenced by advocates.
- a measure the burden of disease using a metric that could also be used to assess the cost-effectiveness of interventions
- the view of the gap between current health status and an ideal situation in which everyone lives into old age free of disease and disability

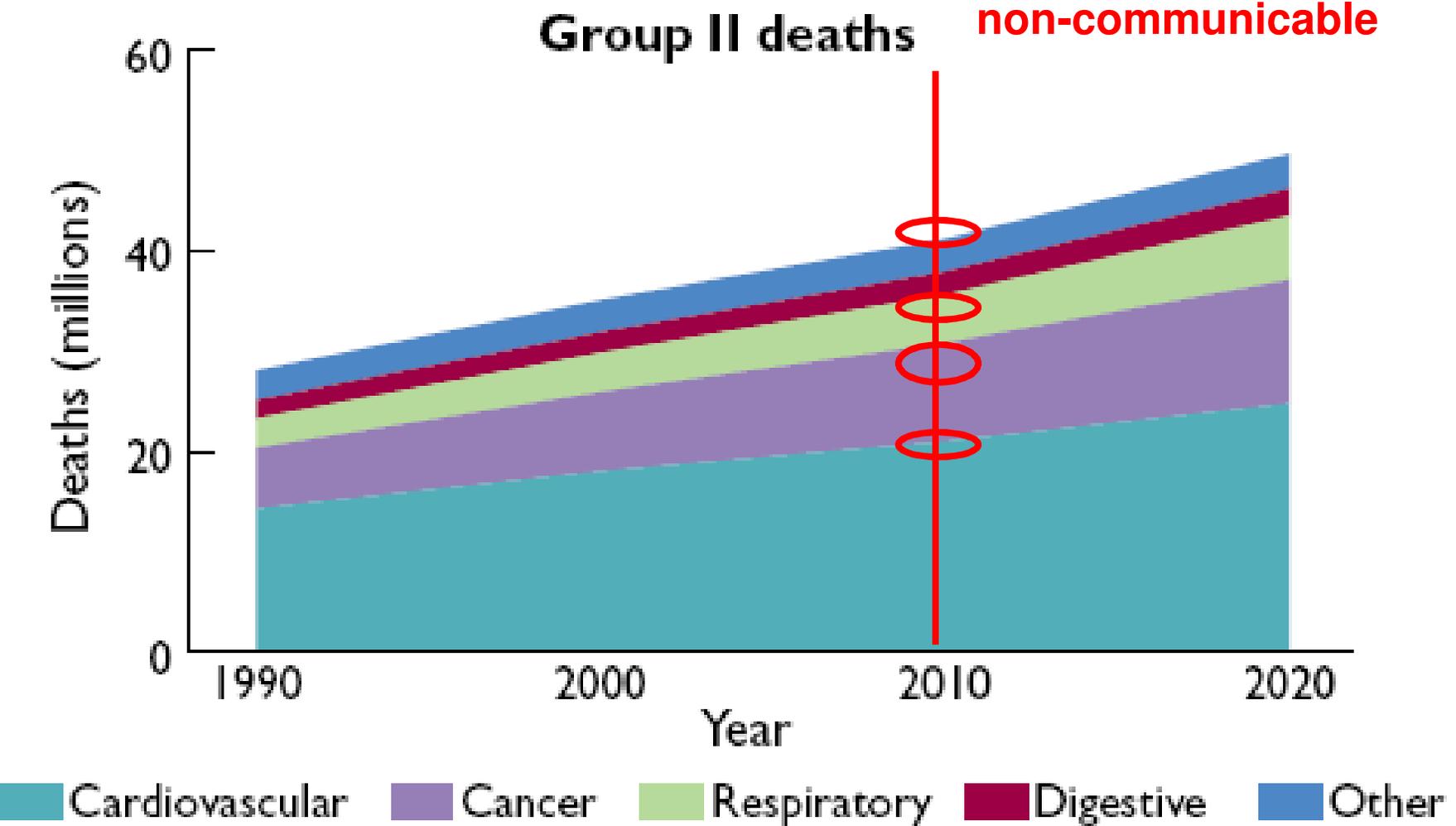
- **45% Global Health burden is due to treatable IDs**
- **Greatest need in health research to address the 90/100 gap is in ID**

Context of the burden: Multifaceted roots

- Urbanization
- Rapidly ageing populations
- Globalization (including food market globalization)
- Poverty
- Poor lifestyle practices
- Weak health systems
- A lack of political will

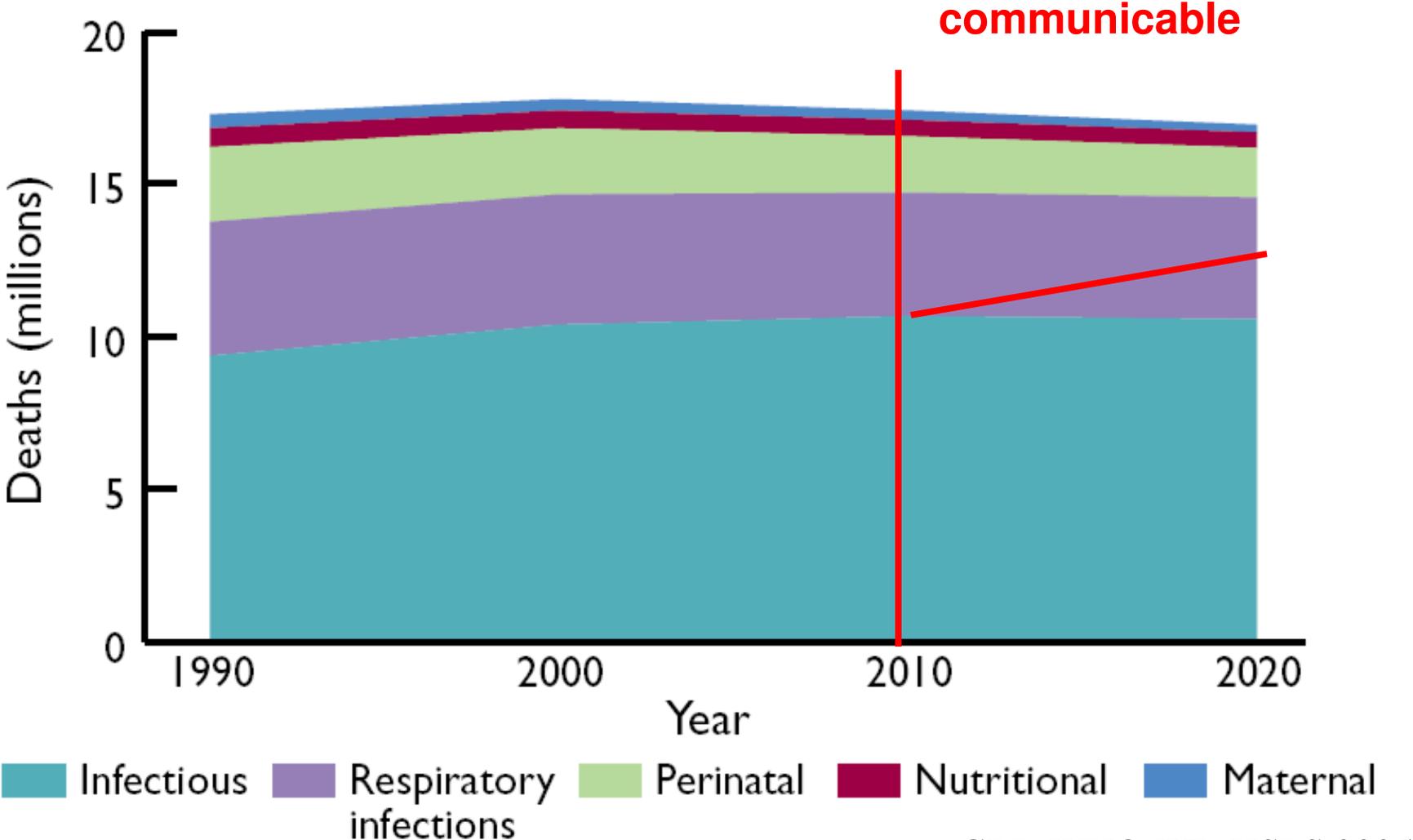


Pessimistic projection of deaths from Group II (non-communicable) causes, world, 1990–2020



GBD WHO-WB-HSPS 2005

Pessimistic projection of deaths from Group I (communicable, maternal and perinatal conditions and nutritional deficiencies) causes, world, 1990–2020



GBD WHO-WB-HSPS 2005

Top leading causes of burden of diseases, world, 1990 and 2020

Global Burden of Disease Study

| 1990 | % DALY | 2020 | % DALY |
|-------------------------------|--------|--|--------|
| 1. Respiratory infections | 8.2 | 1. Ischemic heart disease | 5.9 |
| 2. Diarrheal disease | 7.2 | 2. Major depression | 5.7 |
| 3. Perinatal illnesses | 6.7 | 3. Auto accident | 5.1 |
| 4. Major depression | 3.7 | 4. Cerebrovascular disease | 4.4 |
| 5. Ischemic heart disease | 3.4 | 5. Chronic obstructive pulmonary disease | 4.1 |
| 6. Cerebrovascular disease | 2.8 | 6. Respiratory infections | 3.1 |
| 7. Tuberculosis | 2.8 | 7. Tuberculosis | 3.1 |
| 8. Measles | 2.6 | 8. War | 3.0 |
| 9. Auto accident | 2.5 | 9. Diarrheal disease | 2.7 |
| 10. Congenital birth deficits | 2.4 | 10. HIV | 2.6 |

Ten leading causes of burden of disease, world, 2004 and 2030

| 2004 Disease or injury | As % of total DALYs | Rank | | Rank | As % of total DALYs | 2030 Disease or injury |
|--|---------------------------|------|--|------|---------------------------|--|
| Lower respiratory infections | 6.2 | 1 | | 1 | 6.2 | Unipolar depressive disorders |
| Diarrhoeal diseases | 4.8 | 2 | | 2 | 5.5 | Ischaemic heart disease |
| Unipolar depressive disorders | 4.3 | 3 | | 3 | 4.9 | Road traffic accidents |
| Ischaemic heart disease | 4.1 | 4 | | 4 | 4.3 | Cerebrovascular disease |
| HIV/AIDS | 3.8 | 5 | | 5 | 3.8 | COPD |
| Cerebrovascular disease | 3.1 | 6 | | 6 | 3.2 | Lower respiratory infections |
| Prematurity and low birth weight | 2.9 | 7 | | 7 | 2.9 | Hearing loss, adult onset |
| Birth asphyxia and birth trauma | 2.7 | 8 | | 8 | 2.7 | Refractive errors |
| Road traffic accidents | 2.7 | 9 | | 9 | 2.5 | HIV/AIDS |
| Neonatal infections and other ^a | 2.7 | 10 | | 10 | 2.3 | Diabetes mellitus |
| COPD | 2.0 | 13 | | 11 | 1.9 | Neonatal infections and other ^a |
| Refractive errors | 1.8 | 14 | | 12 | 1.9 | Prematurity and low birth weight |
| Hearing loss, adult onset | 1.8 | 15 | | 15 | 1.9 | Birth asphyxia and birth trauma |
| Diabetes mellitus | 1.3 | 19 | | 18 | 1.6 | Diarrhoeal diseases |

DALYs are useful for policymakers to:

-assess ranking priorities for research and intervention,

-estimate the need of investments,

-to evaluate efficacy of low, medium or high cost interventions

DALYs are useful for policymakers

Are DALYs the best method to evaluate impact of ID?

DALYs are useful for policymakers

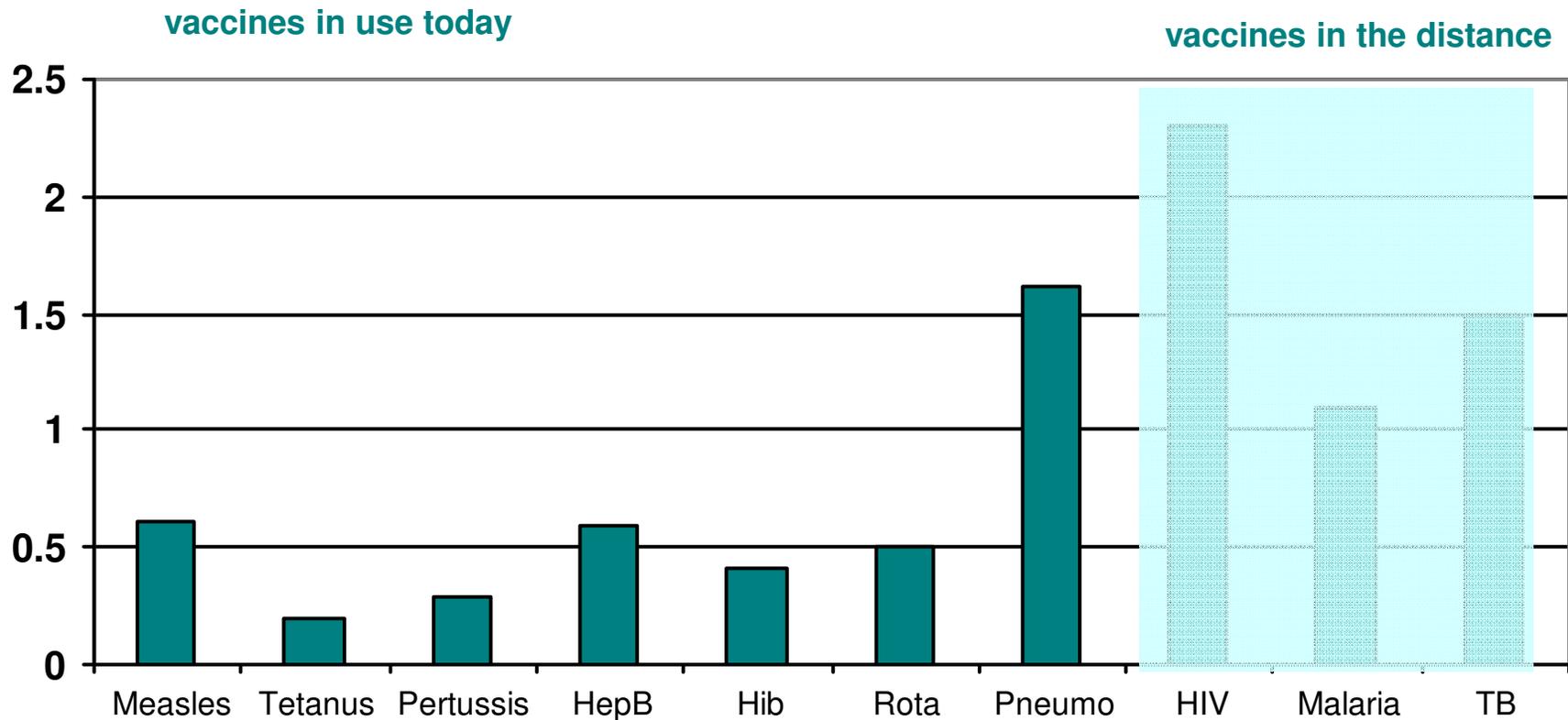
Are DALYs the best method to evaluate impact of ID?

Are DALYs useful to analyze the ID determinants ?

Deaths from some vaccine preventable IDs

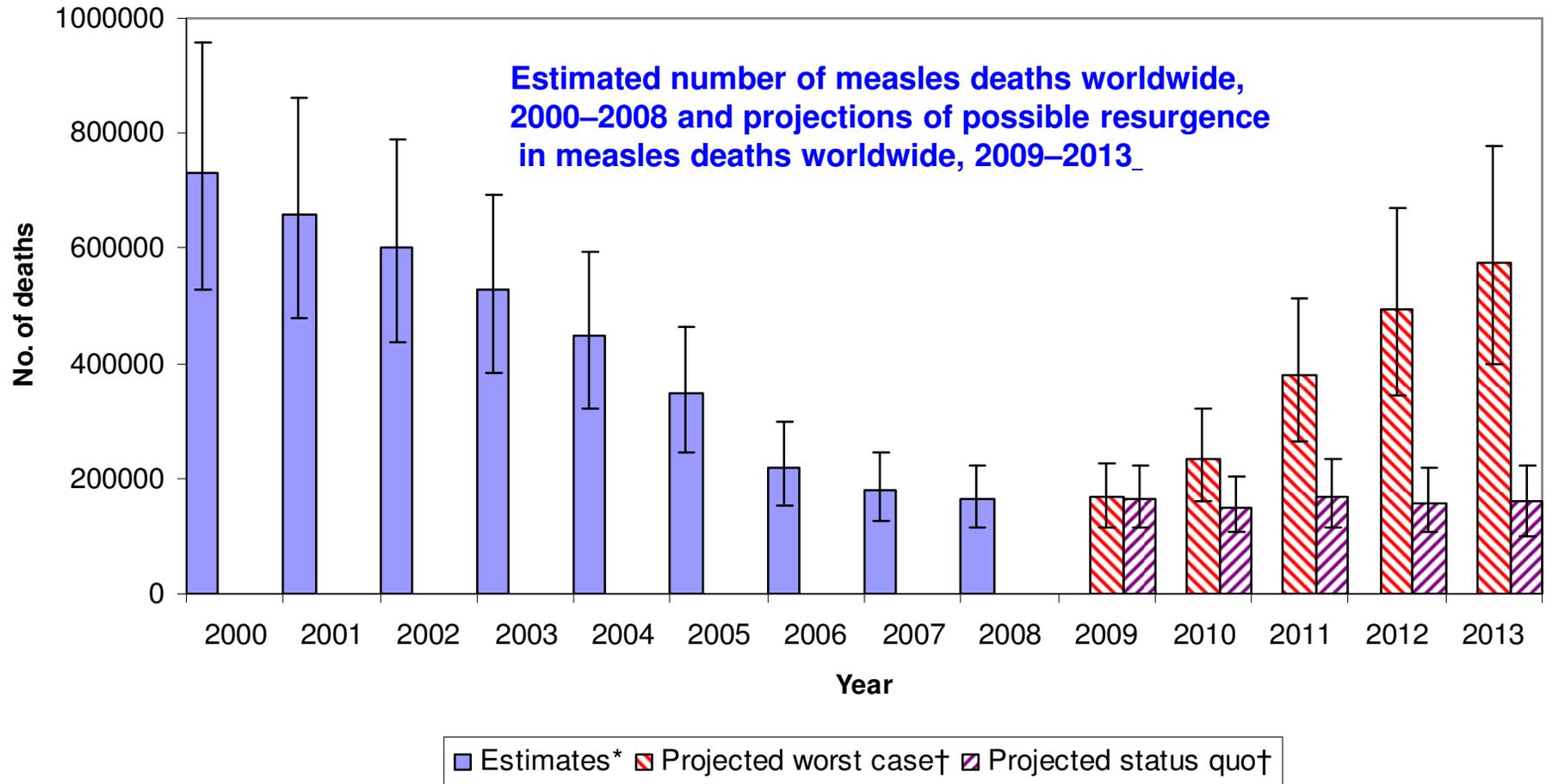
4.3 million deaths per year

6+ million deaths from
AIDS, TB, malaria



Modified from Ruth Levine, Center Global Dev Washington

"Global Measles Deaths Drop by 78% but Resurgence likely"



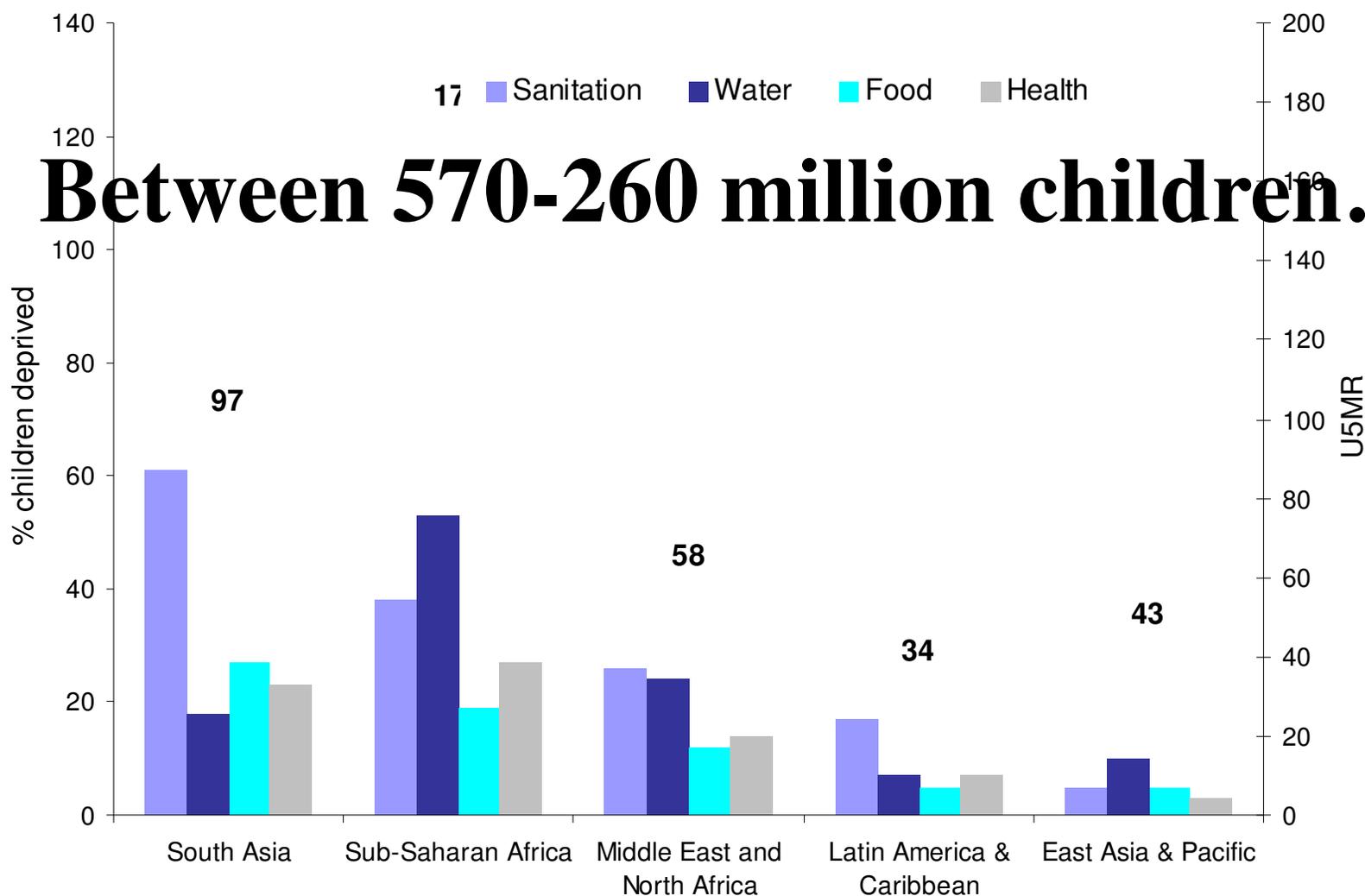
Worst case: MCV1 level, no follow-up SIAs in 47 priority countries

Status quo: MCV1 increases and follow-up SIAs continue, no SIAs in India

Measles: why resurgence?

- no longer perceived as a major threat :
decreased political and financial
commitment
- gaps in immunisation coverage

Children exposed to severe sanitation, water, food and health service deprivation



Gaspar Fajth, UNICEF, 2009

IDs and Economic development

Health and hygiene promotion as economic development

Lower infant mortality rates & higher economic growth

WHO estimates: 10 year increase in average life expectancy at birth translates into a rise of 0.3 – 0.4% in economic growth per year

Deaths from/associated with
Infectious Diseases are just
an indicator of the Burden

**Global burden of
respiratory syncytial virus (RSV)
in young children**

Global worldwide burden of acute lower respiratory infections due to RSV in young children (<5 yr)

- ~ 34 million new episodes of RSV-associated ALRI yearly
- ~ 3.5 million severe RSV-associated ALRI necessitating hospital admission.
- 66 000–199 000 children died yearly from RSV-associated ALRI
- 99% of deaths in developing countries

Estimates of incidence and number of new cases of RSV-associated ALRI and severe ALRI in children younger than 5 years from studies with active and passive case ascertainment, by GBD region

| | RSV-associated ALRI | | RSV-associated severe ALRI | |
|-----------------|--|---|--|---|
| | Incidence in children aged <1 year (per 1000 per year) | Number of new cases in children aged <5 years in 2005 ($\times 10^3$) | Incidence in children aged <1 year (per 1000 per year) | Number of new cases in children aged <5 years in 2005 ($\times 10^3$) |
| Developing* | 59.1 (40–87.5) | 32512 | 5.6 (4.3–7.4) | 3080.7 |
| Industrialised† | 24 (19.8–30) | 1301.7 | 5.5 (4.2–7.2) | 298.3 |
| Total‡ | 48.5 (31.4–74.9) | 33813.7 | 5.6 (4.5–7) | 3379 |

Malaria

Global Burden of Malaria

- Every year, 500 million people become severely ill with malaria
- >1 million people die of malaria every year
- One child dies from it every 30 seconds
- 40% of the world's population is at risk of malaria.
- Malaria is the 9th leading cause of death

Malaria: 30% overprescription and underdiagnosis

Am. J. Trop. Med. Hyg., 80(5), 2009, pp. 712–717
Copyright © 2009 by The American Society of Tropical Medicine and Hygiene

Accuracy of Malaria Diagnosis by Microscopy, Rapid Diagnostic Test, and PCR Methods and Evidence of Antimalarial Overprescription in Non-Severe Febrile Patients in Two Tanzanian Hospitals

Emanuele Nicastrì, Nazario Bevilacqua,* Monica Sañé Schepisi, Maria G. Paglia, Silvia Meschi, Shaali M. Ame, Jape A. Mohamed, Sabina Mangi, Robert Fumakule, Antonino Di Caro, Maria R. Capobianchi, Andrew Kitua, Fabrizio Molteni, Vincenzo Racalbuto, and Giuseppe Ippolito

Virology and Microbiology Laboratories, Epidemiology and Clinical Departments, National Institute for Infectious Diseases Lazzaro Spallanzani (INMI), Via Portuense 292, 00149 Rome, Italy; Public Health Laboratory–Ivo De Carneri Pemba, Chake Chake Hospital, Pemba, Zanzibar; Tosamaganga Hospital, United Republic of Tanzania; National Institute for Medical Research, Dar es Salaam, United Republic of Tanzania; Italian Cooperation, Italian Ministry of Foreign Affairs, Rome Italy

B&C Hepatitis viruses Infections

Global Burden—Hepatitis B Virus Infection

- Estimated ~ 2 billion people infected with HBV
- >350 million have chronic HBV infection
- ~ 88% of the world's population live in areas where the prevalence of chronic HBV infection is high (>8% HBsAg +) or moderate (2-7% HBsAg +)
- Estimated ~620000 HBV-related deaths yearly
- ~ 93% of deaths were the result of chronic infection

Hepatitis B Disease Burden

| <u>Region</u> | <u>Percent Global Deaths</u> |
|---------------|------------------------------|
| AFRO | 11% |
| AMRO | 2% |
| EMRO | 3% |
| EURO | 8% |
| SEARO | 23% |
| WPRO | 52% |
| Global | 100% |

Bridging from Cirrhosis/HCC to Hepatitis

- Major drivers of HBV/HCV burden are cirrhosis/HCC
- 57% of cirrhosis attributable to either HBV or HCV
 - 30% of cirrhosis was attributable to HBV
 - 27% of cirrhosis was attributable to HCV
- 78% of HCC attributable to HBV or HCV
 - 53% of HCC was attributable to HBV
 - 25% of HCC was attributable to HCV
- About 450,000 deaths due to HBV and HCV cirrosis
- More than 450,000 deaths due to HBV and HCV liver cancer

Hepatitis C: Disease Burden

Estimated 170 million infected

- ~ 130 million **chronically**
- ~ 3-4 million new infections a year
- 1 in 3 woman and 1 in 2 men will **develop cirrhosis** and/or Liver **Cancer**
- Responsible for 50-76% of **ALL** liver cancer cases
- Responsible for 2/3 of **ALL** liver transplants in the developed world

Dengue: an example



More than 1,000 exposed to dengue in Florida: CDC

WASHINGTON | Tue Jul 13, 2010 5:14pm EDT

(Reuters) - Five percent of the population of Key West, Florida -- more than 1,000 people -- have been infected at some point with the dengue virus, government researchers reported on Tuesday.

Florida Dengue Fever Outbreak Leads Back to CIA and Army Experiments

 August 5, 2010 by POPEYE

 1 Comment

Filed under [Eugenics](#)

(TRUTHOUT) With little fanfare on July 13, Florida officials released the findings of a Centers for Disease Control (CDC) study conducted recently in the Key West area revealing that about 10 percent, or 1,000 people, of the coastal town's population are infected with the dengue fever virus.

While the July 13 release made little mention of it, the CDC study was provoked by an earlier 2009 report that a woman in New York State, who had returned from a Florida Keys' visit, had contracted dengue fever. Within a few weeks of this initial report, two additional cases were discovered in people who had returned from Key West. Over the next three months of 2009, an additional 26 cases were identified, all tied to visits to the town.

Dengue and Public Health

- Dengue fever is a major public health problem
- The reasons for the emergence of this disease are complex
 - Effective mosquito control is virtually nonexistent in most dengue-endemic countries
 - Major global demographic changes have occurred
 - Uncontrolled urbanization
 - Concurrent population growth
 - Substandard housing, inadequate water, sewer, and waste management systems



New Estimates of the Burden of Dengue

| | New Estimates | Earlier Estimates |
|---|---------------------------------------|---|
| Population at risk | 3.6 billion (55% of world population) | 2.5 - 3 billion (40% of world population) |
| Endemic countries | 124 | >100 |
| Dengue Infections*/year | 70-500 million | 50 - 100 million |
| Cases symptomatic of Dengue Fever/year | 36 million | |
| Cases of Dengue Haemorrhagic Fever and Dengue Shock Syndrome/year | 2.1 million | 250,000 - 500,000 |
| Deaths/ year | 21,000 | 20,000 |

*Includes asymptomatic infection which increases risk of more severe disease with subsequent infection

WHO, 2010; Callaway E. Nature 2007; 448:734-735

Why Dengue is a major international public health concern

- Dengue is of major international public health concern because of the increasing range of its carriers
- Increased frequency of epidemics
- Co-circulation of multiple virus serotypes,
- Emergence of dengue hemorrhagic fever in new areas

Infectious Disease: Dengue Risk



- In 1990, **almost 30% of the world population, 1.5 billion people**, lived in regions where the estimated risk of dengue transmission was **>50%**
- In 2085, an **estimated 50-60% of the projected global population, 5-6 billion people**, would be at risk of dengue transmission, compared with 35% (3.5 billion) if climate change didn't happen.

Pharmaceutical Research: Priority Areas, WHO (2004)

| <u>Priority</u> | <u>Condition</u> | <u>Priority</u> | <u>Condition</u> |
|-----------------|-------------------------|-----------------|-----------------------|
| 1 | Infections/resistance | 9 | Neglected diseases* |
| 2 | Pandemic influenza | 10 | Malaria |
| 3 | Cardiovascular diseases | 11 | Alzheimer's |
| 4 | Diabetes (1 and 2) | 12 | Osteoarthritis |
| 5 | Cancer | 13 | COPD |
| 6 | Acute stroke | 14 | Alcohol disorders |
| 7 | HIV/AIDS | 15 | Depression |
| 8 | Tuberculosis | 16 | Postpartum hemorrhage |

*trypanosomiasis, Buruli ulcer, leishmaniasis, Chagas disease

Urgent needs

- globally-coordinated research and development effort to devise and implement cost-effective approaches to data collection and analysis in poor countries that is targeted to their health development needs, and
- that can routinely yield comparable information of sufficient quality to establish how disease and risk factor burden is changing in populations.

Science for Policy

Policy, not charity, will determine whether modern science and technology become a tool for development everywhereand for all

Goverdhan Mehta,
ICSU President

Ethics, Policy and Politics



**There is enough on this earth
for everyone's needs but not
for everyone's greed**

Mahatma Gandhi

Conclusion

Decision Making and Infectious Diseases

- Political will:
 - Burden of disease
 - Perception and promotion of outcome
 - Impact on over all health services sector
 - Impact on over all development
 - Luck



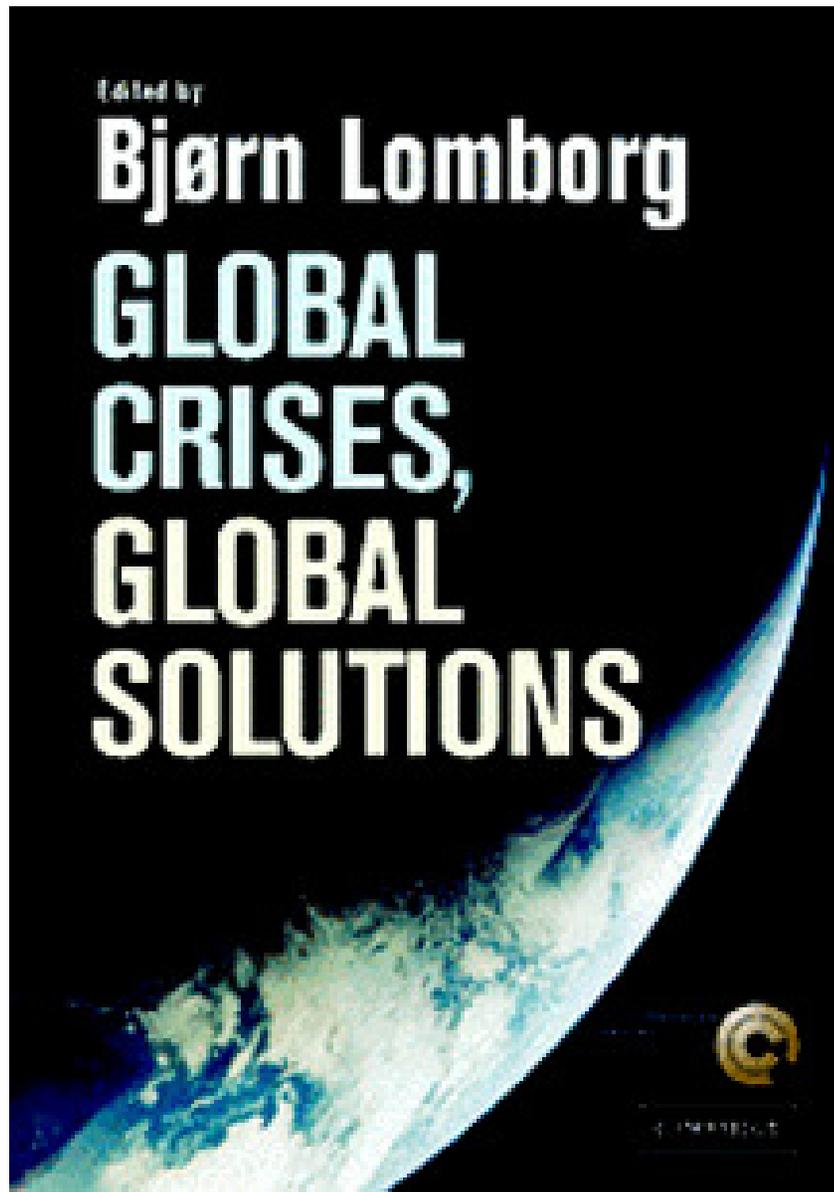
*The danger is not that we will
aim too high and fail to
achieve our goals, but that we
will aim too low and achieve
them.*



Michelangelo Buonarroti







We need better Information:
Health, Education, Conflicts,
Financial Instability

Copenhagen Consensus 2008

Interventions expected to be effective

- Organised Collaborations
- Networks based on equality of partners
- Government linked strategies
- Joint interventions are working better
- Long-term integrated strategies
- Multi-disciplinary responses

“Know before you act everything possible from all intelligence or your plans shall fail if you are unprepared you will be defeated”

Julius Caesar 51 BC

Why this conference is so important?

SIXTH WORLD CONFERENCE ON
THE FUTURE OF SCIENCE™



Viruses: the invisible enemy

VENICE, SEPTEMBER 19-21, 2010

Why this conference is very
important?

Silence will not cure a disease.
On the contrary; it will make it worse.

Leo Tolstoy