

EMERGING INFECTIOUS DISEASES

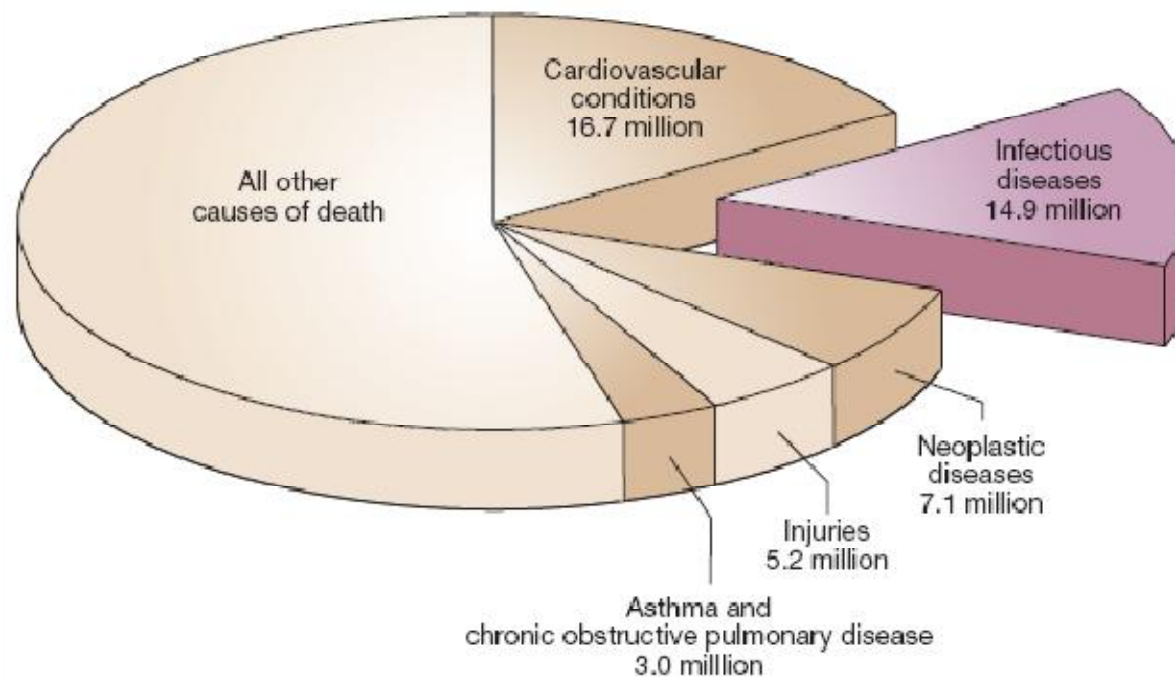
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Outline

- Importance and impact of EIDs
- Some definitions
- Host range and EIDs and REIDs
- Global trends
- Getting ready for the future

Leading causes of death worldwide. About 15 million (>25%) of 57 million annual deaths worldwide are the direct result of infectious disease. (<http://www.who.int/whr/en>)



Infectious diseases	Annual deaths (million)
Respiratory infections	3.96
HIV/AIDS	2.77
Diarrhoeal diseases	1.80
Tuberculosis	1.56
Vaccine-preventable childhood diseases	1.12
Malaria	1.27
STDs (other than HIV)	0.18
Meningitis	0.17
Hepatitis B and C	0.16
Tropical parasitic diseases	0.13
Dengue	0.02
Other infectious diseases	1.76

Not included the additional millions of deaths that occur as a consequence of past infections (for example, streptococcal rheumatic heart disease), or because of complications associated with chronic infections, such as liver failure and hepatocellular carcinoma in people infected with hepatitis B or C viruses.

EIDS: PREPARING FOR THE FUTURE

- IDs account for a quarter of all human mortality and a similar fraction of morbidity (www.who.int/whr/2005/en/)
- IDs of crops and livestock cost the global economy many billions of euros every year
- Sudden epidemics of IDs can deliver humanitarian and economic shocks on a scale difficult to absorb.

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WB Report 2003: SARS epidemic, which killed < 1000 people, was responsible for an estimated fall of 2% in GDP across East Asia

- Outbreaks of livestock diseases (FMD, BSE, CSF, AI...) and crop diseases (Soybean rust, Southern corn leaf blight) costing individual countries billions of euros

The UN Millenium Development goals* for reducing the burden of IDs (HIV, TB, malaria), poverty and hunger (compromised by livestock and crop diseases) are gloomy: in most developing regions, where the impacts of IDs are greatest, little hope of meeting any of these goals by 2015

*United Nations, The Millenium Development goals Report 2005, New York 2005

EMERGING INFECTIONS

“infections that have newly appeared in a population or have existed previously but are rapidly increasing in incidence or geographic range”

Morse, S. S. *Emerg. Infect. Dis.* 1, 7–15 (1995).

Re-emerging and resurging infections

- Re-emerging and resurging infections are those that existed in the past but are now rapidly increasing either in incidence or in geographical or human host range.
- Re-emergence is caused by some of the factors that cause newly emerging infectious diseases, such as microbial evolutionary vigour, zoonotic encounters and environmental encroachment.
- Re-emergences or at least cyclical resurgences of some diseases may also be climate-related — for example, the El Niño/Southern Oscillation (ENSO) phenomenon is associated with resurgences of cholera and malaria.

Old microbes cause new diseases

- *Streptococcus pyogenes* caused a fatal pandemic of scarlet and puerperal fevers between 1830 and 1900
- Scarlet fever is now rare and replaced by other streptococcal complications such as streptococcal toxic shock syndrome, necrotizing fasciitis and re-emergent rheumatic fever
- Virulence factors identified, among them bacteriophage-encoded superantigen toxins and a protein known as sialin (streptococcal inhibitor of complement), which seems to be strongly selected by human host mucosal factors.
- The changes in streptococcal virulence reflect genetic changes associated with phage integration, large-scale chromosomal rearrangements and possibly the shuffling of virulence cassettes followed by rapid human spread and immune selection.

- Similar story with the Koch-Weeks bacillus. More than a century later, a fatal EI dubbed Brazilian purpuric fever was linked to virulent clonal variants of *Haemophilus influenzae* biogroup *aegyptius* (the Koch–Weeks bacillus)

Microbial agents and chronic diseases

- Infectious agents that are associated with chronic diseases are one of the most challenging categories of newly emerging (or at least newly appreciated) infections.
- Examples include the associations of hepatitis B and C with chronic liver damage and hepatocellular carcinoma, certain genotypes of human papillomaviruses with cancer of the uterine cervix, Epstein–Barr virus with Burkitt’s lymphoma (largely in Africa) and nasopharyngeal carcinoma (in China), human herpesvirus 8 with Kaposi sarcoma, and *Helicobacter pylori* with peptic ulcers and gastric cancer.
- Some data even suggest infectious aetiologies for cardiovascular disease and diabetes mellitus, major causes of death and disability worldwide. Other associations between infectious agents and idiopathic chronic diseases will inevitably be found.

HOST RANGE AND EMERGING AND REEMERGING PATHOGENS

1407 Human pathogen species

177 (13%) species regarded as emerging or reemerging

Viruses: 208, and 77 (37%) emerging or reemerging

Bacteria: 538, and 54 (10%), respectively

Fungi: 317, and 22 (7%), respectively

Protozoa: 57, and 14 (25%), respectively

Helminths: 287, and 10 (3%)

HOST RANGE AND EMERGING REEMERGING PATHOGENS

TAXONOMY

- More than 20 virus families contain human pathogens; four account for more than half of the species affecting humans and, likewise, more than half of the emerging and reemerging species (*Bunyaviridae*, *Flaviviridae*, *Togaviridae*, *Reoviridae*)
- More than 60 bacteria families contain human pathogens; enterobacteria and mycobacteria account for the most species and for the most emerging and reemerging diseases
- In fungi, protozoa and helminths, no indication found that emerging and reemerging species are concentrated in any particular taxa.

HOST RANGE AND EMERGING REEMERGING PATHOGENS

Host range

- Of the 1407 human pathogen species, 816 (58%) are known to be zoonotic
- In comparison, 177 emerging and reemerging pathogens, 130 (73%) are known to be zoonotic
- Host types: ungulates predominate. Emerging and reemerging pathogens show similar trends, ungulates support over 50 species.

EMERGING AND REEMERGING PATHOGENS

1. Are disproportionately viruses. RNA viruses dominate, comprising 37% of all emerging and reemerging pathogens
2. Are not strongly associated with particular nonhuman host types, but they are most likely to have the broadest host ranges

GLOBAL TRENDS IN EIDS.

Analysis of a database of 335 EID “events” between 1940-2004*

- Non-random global patterns
- EIDs have risen significantly over time after controlling for reporting bias (first analytical support for previous suggestions that the threat of EIDs to global health is increasing)
- Their peak incidence in the 1980s concomitant with the HIV pandemic

*Jones KT et al, Nature 2008;451:990-94

GLOBAL TRENDS IN EIDS.

Analysis of a database of 335 EID “events” between 1940-2004*

EIDs events dominated by:

- Zoonoses (60.3% of EIDs). The majority originate in wildlife (SARS, Nipah, Ebola), increasing significantly over time.
- 54,3% caused by bacteria or rickettsia, reflecting a large number of drug-resistant organisms in the database.
- Results confirm that EID origins are significantly correlated with socio-economic, environmental and ecological factors
- Provide the basis for identifying regions where new EIDs are most likely to originate (EID hotspots)
- Increasing risk of wildlife zoonotic and vector-borne EIDs at lower latitudes where reporting efforts are low

*Jones KT et al, Nature 2008;451:990-94

GLOBAL TRENDS IN EIDS.

Analysis of a database of 335 EID “events” between 1940-2004*

- Global resources are poorly allocated and mainly focused on countries from where the next EID is least likely to originate
- It supports the notion that zoonotic EIDs represent an increasing and very significant threat to global health.

The importance of understanding the factors that increase contact between wildlife and humans in developing predictive approaches to disease emergence.

*Jones KT et al, Nature 2008;451:990-94

LONG TERM CHALLENGES

- Most factors that contribute to disease emergence will continue, if not intensify, in the century:
 - Social factors (lack of adequate health care and increases in international travel)
 - Demographic factors (aging of the population, urbanization, population growth)
 - Environmental factors (global climate change, lack of adequate sanitation, land use practices)
 - Microbial evolution

EIDs- HEALTH ISSUES FOR THE FUTURE

- Rapid detection of EIDs is essential to minimize illness, disability, death and economic losses
- Public health surveillance- the ongoing systematic collection, analysis, interpretation, and dissemination of health data- is the cornerstone
 - The usefulness of incorporating new technologies- molecular tools (biosensors, high density DNA microarrays) and rapid communication methods
- Clinicians are often the first to recognize a new disease problem. The creation of networks of medical specialists in emergency medicine, infectious diseases, and travel medicine, formed recently, should enhance collaboration about EIDs
- The need for multisector responses to EIDs threats (agriculture, economic development, vaccines)

“The future of microbes and mankind will probably unfold as episodes of a suspense thriller that could be entitled *Our wits versus their genes*”

Joshua Lederberg, *Science* 2000;288:287