

NATIONAL MICROBIAL MONITORING PROGRAMME

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Emerging and Re-emerging Pathogens

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Infectious Diseases

- Pathogenic (disease-causing) microorganisms have repeatedly altered the course of human history.
 - 1918-1920: influenza pandemic caused 70 millions deaths worldwide.
 - Since 1817 at least 7 cholera pandemics.
 - Recently, HIV, SARS etc.
- In 2001, infectious diseases accounted for an estimated 26% of deaths worldwide (Kindhauser, 2003).

Table 1

Examples of recently emerging pathogens

Microbe	Disease	Year
Rotavirus	Infantile gastroenteritis	1973
<i>Legionella pneumophila</i>	Legionnaires disease	1977
Ebola virus	Ebola hemorrhagic fever	1977
<i>Borrelia burgdorferi</i>	Lyme disease	1982
HIV	AIDS	1983
Hepatitis C virus	Hepatitis	1989
<i>Vibrio cholerae</i> O139	Cholera	1992
Sin Nombre virus	Hantavirus pulmonary syndrome	1993
Human herpesvirus 8	Kaposi sarcoma in AIDS patients	1995
Influenza virus A H5N1	Influenza	1997 ^A
SARS coronavirus	Severe acute respiratory syndrome	2002

^AFirst human cases; virus previously known to infect birds.

Locations of recent outbreaks of emerging infectious diseases (WHO 2002)





Pathogenic organisms

- By 2001, a total of 1415 species of infectious organisms known to be pathogenic to humans had been recorded.
 - 217 viruses and prions
 - 100 bacteria and rickettsiae
 - 66 protozoa
 - 287 helminths
- 61 % were zoonotic and 12% were considered to be emerging (Taylor, Latham and Woolhouse, 2001).



What are emerging pathogens?

- Emerging pathogens are those that have appeared in a human population for the first time or have occurred previously but are increasing in incidence or expanding into areas where they have not previously been reported usually over the last 20 years. (WHO, 1997)

What are emerging pathogens?

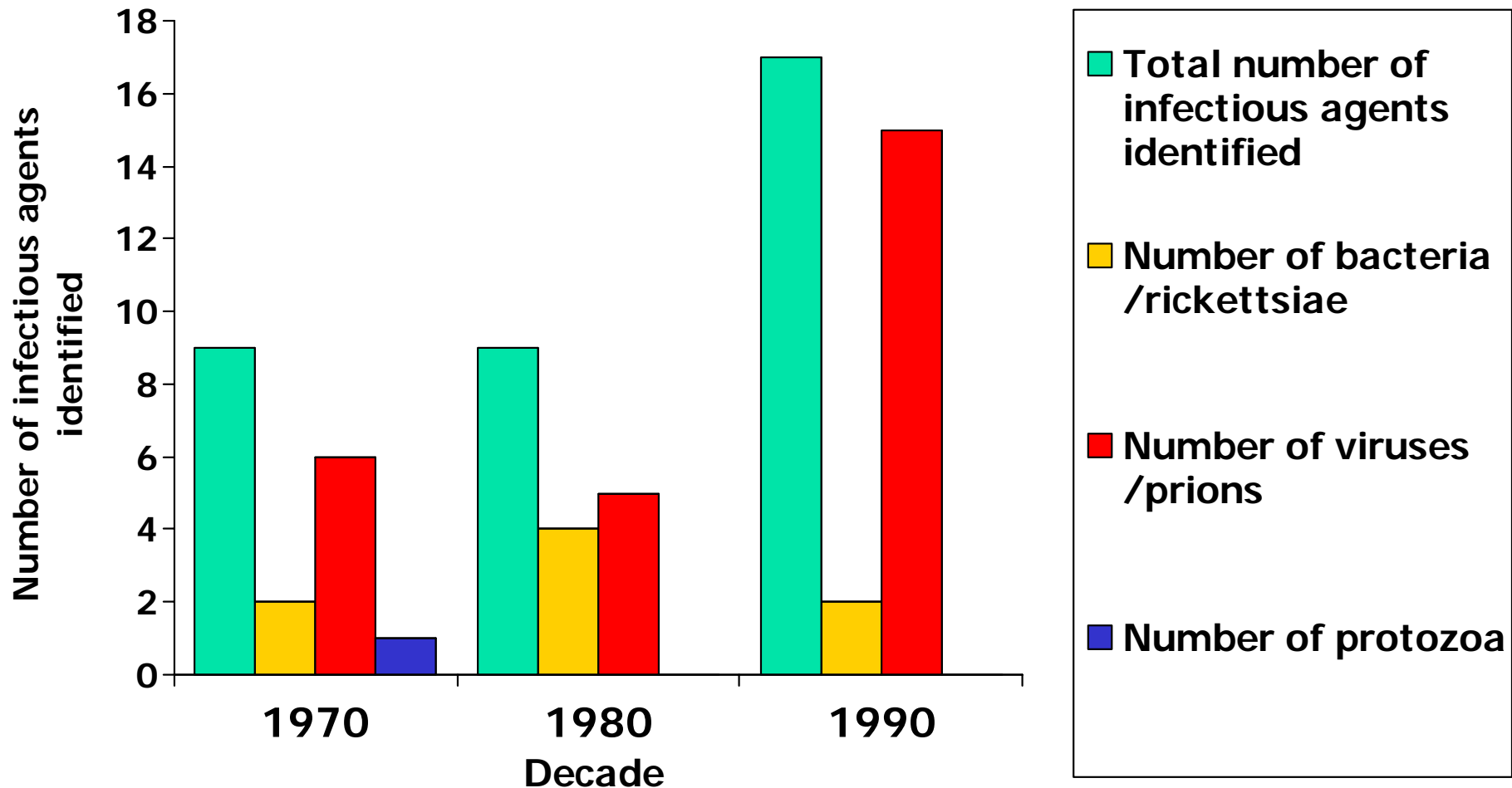


- Re-emerging pathogens are those whose incidence is increasing as a result of long term changes in their underlying epidemiology (Woolhouse, 2002)

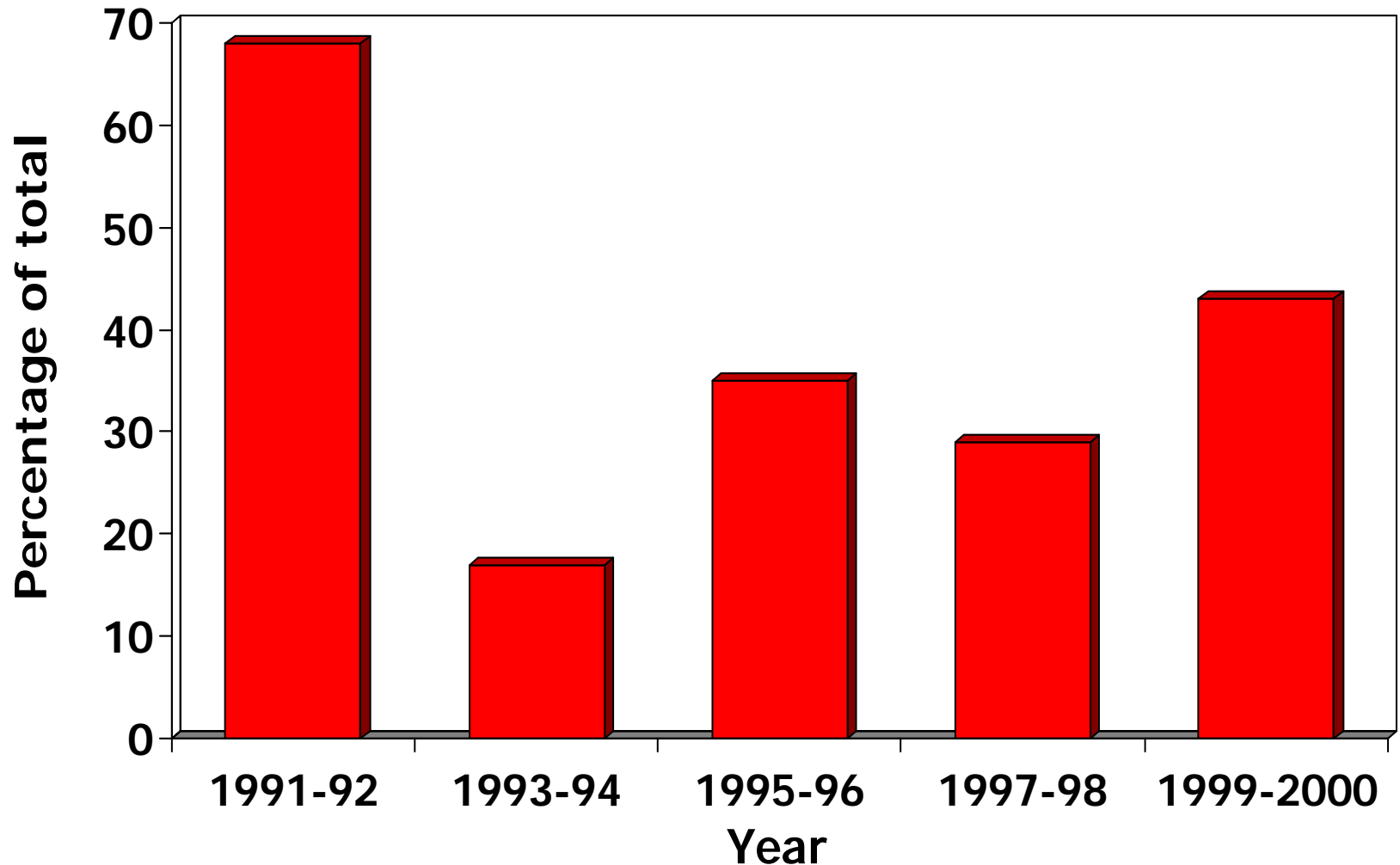
Categories of Emerging and Re-emerging Infectious Diseases:

Emerging	<p>Newly identified pathogens and syndromes: HIV/AIDS, <i>Hepatitis C</i>, <i>V. cholerae</i> O139, Lyme disease, Legionnaires' diseases, SARS</p>	<p>Evolution in existing organisms or new techniques identified existing organisms or transmission to human from other hosts.</p>
	<p>Re-emergence of old diseases: Cholera, dengue, yellow fever, Ebola virus, West Nile virus</p>	<p>Spread of old disease to new area or population ecological changes, environmental resources that harbor pathogens and breakdown of public health measures.</p>
Re-emerging	<p>Emergence of organisms resistant to antimicrobial agents: TB, malaria, shigellosis, Salmonella infections,</p>	<p>Overuse of inappropriate use of antimicrobial agents, poor sanitation, immunocompromised or malnourished population.</p>

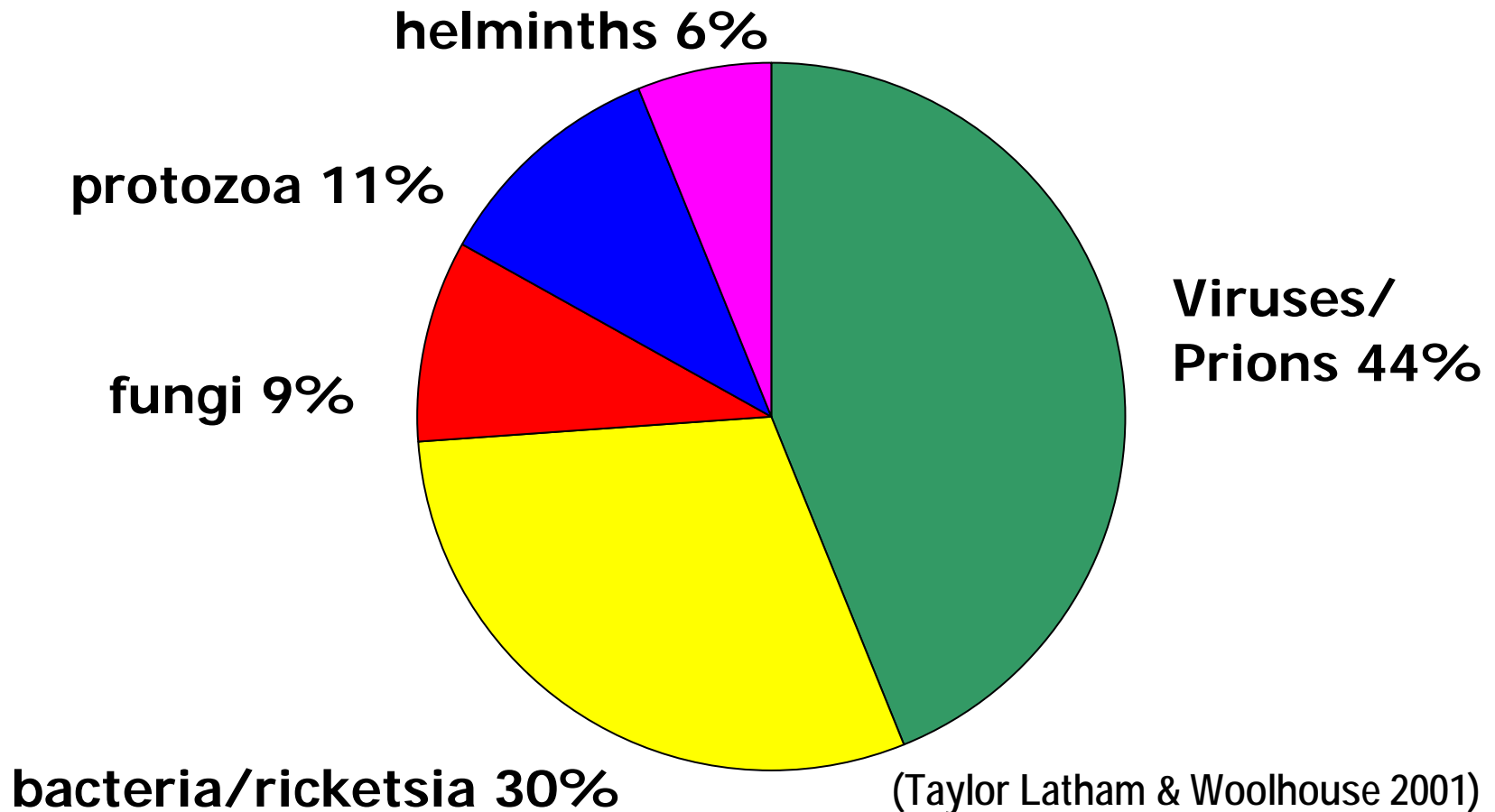
Rate of discovery of emerging pathogens 1970-2000



Drinking-water disease outbreaks of unknown etiology in the USA 1990-2000



The distribution of emerging pathogens according to the main groups of microorganisms





Why do pathogens emerge?

Most have a common theme and can be grouped under a few general headings:

- New Environments;
- New technologies;
- Scientific advances,
- Changes in human population, behaviour and vulnerability.



New Environments

- Climate shifts/deforestation
- Water-cooled air conditioning plants
- Water resources development (dams and irrigation)



Cases: New Environments

- **Climate shifts/deforestation**
 - Expanding the range of mosquito species responsible for the transmission of the malarial parasite and the dengue virus.
 - Malaria is now occurring high in the mountains of central Africa and in the highlands of Papua New Guinea.
- **Water-cooled air conditioning plants.**
 - In 1976, an outbreak of pneumonia (Legionnaires disease) at an American Legion Convention → *Legionella pneumophila*.



Cases: New Environments

- **Water resources development project (dams and irrigation)**
 - The Aswan High Dam in Egypt
 - Increasing prevalence of schistosomiasis
 - the redistribution of the two species of snail, *Bulinus truncatus* and *Biomphalaria alexandrina* (the intermediate host)
 - The Itaparica Dam reservoir in Brazil, 1988
 - 2000 gastro-enteritis cases
 - Toxin produced by Cyanobacteria as the responsible agent.



Cases: New Environments

A natural environmental bacterium can exploit a niche within man-made water systems and emerge as a significant pathogen.



New technologies

- Changing industrial and agricultural practices (livestock rearing)
- Waterborne sewage and sewage treatment alternatives
- Piped water systems and their inadequate design and operation



Cases: New Technologies

- Changing industrial and agricultural practices (livestock rearing)
 - Zoonotic pathogens are almost twice as likely to be regarded as emerging or re-emerging than non-zoonotic pathogens
 - implications for intensive livestock farming:
Cryptosporidium, E. coli O157 and Campylobacter.
- Waterborne sewage and sewage treatment alternatives



Cases: New Technologies

- Piped water systems and their inadequate design and operation
 - Outbreaks through leaks of the system, and during maintenance work.
 - Biofilms e.g. *Mycobacterium avium complex*



New Technologies

New water treatment, storage and distribution technologies are being developed to improve and maintain the quality of drinking water. But unforeseen problems with a few technologies may introduce new risks that may lead to the re-emergence of water-related pathogens.



Scientific advances in water microbiology

- Improved methods of detection and analysis
- Inappropriate, excessive use of antibiotics, anti-parasitic drugs and insecticides



Scientific advances in water microbiology

- **Improved methods of detection and analysis**
 - Improved selective media for pathogens
 - New techniques to visualization of organisms, e.g. EM, Fluorescence microscopy, antibody techniques
 - Cell culture → mammalian viruses
 - Genetic analysis especially PCR

In 1972 and 1973, the **caliciviruses and rotaviruses** were identified as the causative agents of diarrhoea. Subsequent work has shown these two groups to be a significant cause of mortality amongst children.



Cases: Scientific advances

- **Emerging resistance to antimicrobial drugs**

- The changing dynamics of growing population and the overuse of antibiotics.

- ▶ *S. aureus* (30-40% MRSA)

- ▶ *Mycobacterium tuberculosis* (15% MDR)

- ▶ *Enterobacteriaceae* isolates (95% is resistant at least one antibiotic tested)



Changes in human population, behaviour and vulnerability

- Human circulation and accessibility and rapidity of transport worldwide
- Demographic changes
- Increase in size of high risks populations
- An increasing number of humanitarian emergencies



Cases: Changes in human population and vulnerability

- Increase in size of high risks populations
 - In combination, the aging of the world's population, the use of immunosuppressive procedures and the global spread of HIV/AIDS have created a large and growing population with impaired immune systems.
- **Cryptosporidium and MAC**



Cases: Changes in human population and vulnerability

- **Human Migration**

- Desertification, deforestation, urbanization
- Most notable are diseases that have emerged as humans have encroached upon forest regions, bringing people into closer contact with animal species carrying pathogens that can be transmitted across the species barrier, e.g. **HIV, SARS, Influenza A virus.**

- **Tourism**



Conclusions

- Human development and population growth exert many and diverse pressures on the quality and quantity of resources eg water and on access to them.
- Understanding why pathogens emerge or re-emerge is fundamental to effective water resource management, drinking water treatment and delivery. It is important to be able to gauge the risks from any emerging disease.



Conclusions (cont'd)

- Investigating important emerging issues in water and infectious disease and communicating discoveries create unique challenges.
- Developing effective monitoring programmes (e.g. NMMP & DoH Microbial Monitoring Initiatives) both nationally and internationally to reduce the health risks is imperative