

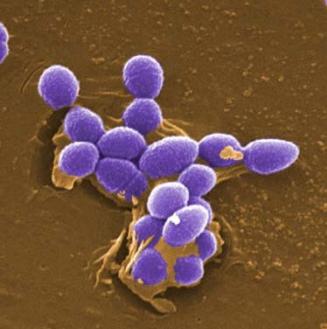
**Streptococcus pneumoniae**



**Streptococcus pyogenes**



**Staphylococcus aureus**



**Enterococci**



**Mycobacterium tuberculosis**



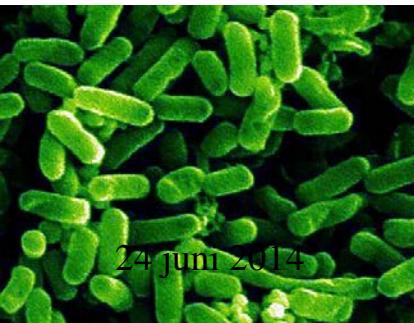
**Hemophilus influenzae**

# Spread of antibiotic resistance

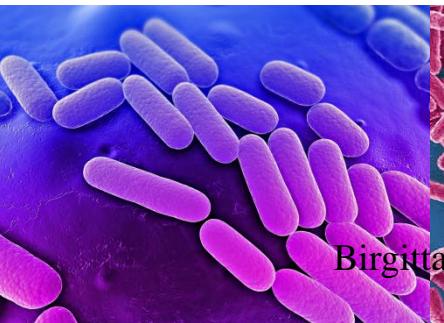
Birgitta Henriques Normark, MD, PhD, Professor

Karolinska Institutet, Karolinska University Hospital, Public Health Agency Sweden

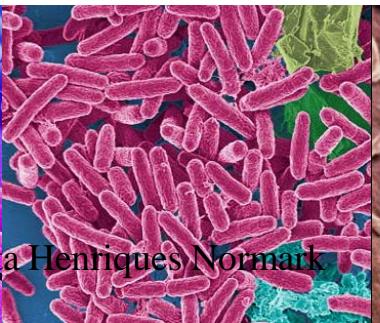
**E. coli**



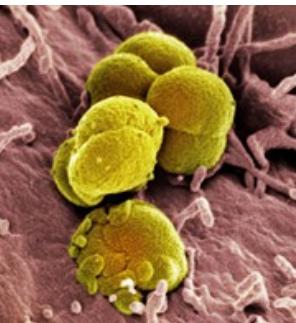
**Klebsiella**



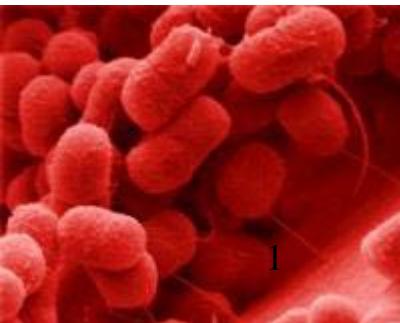
**Pseudomonas aeruginosa**



**Gonococci**

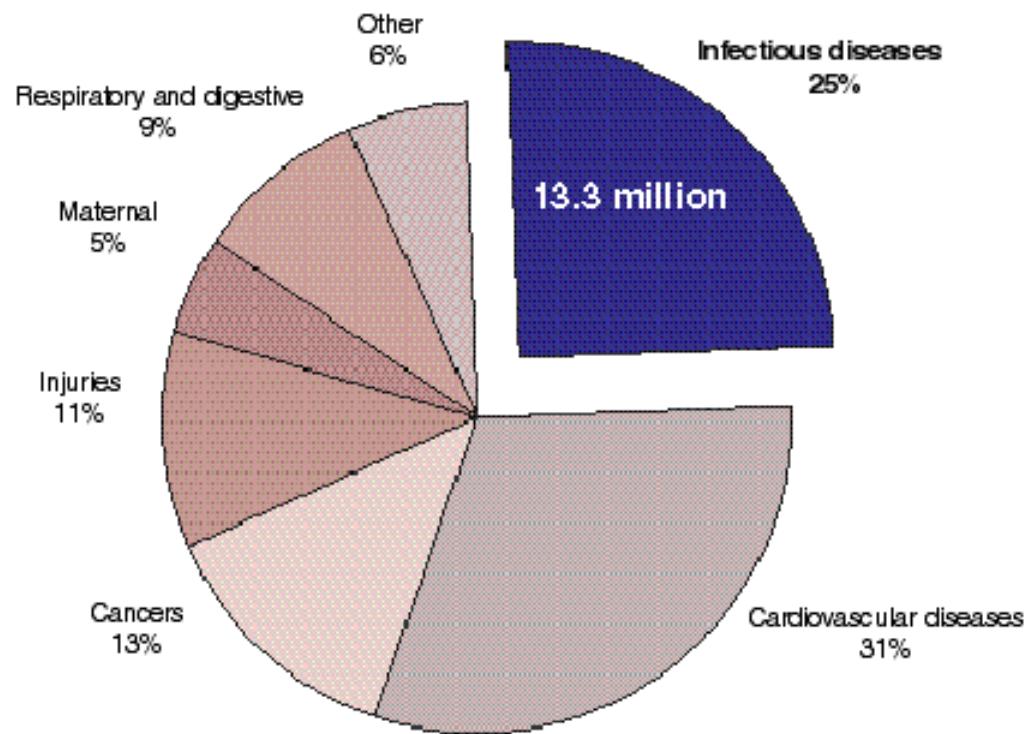


**Acinetobacter**



# Leading causes of death

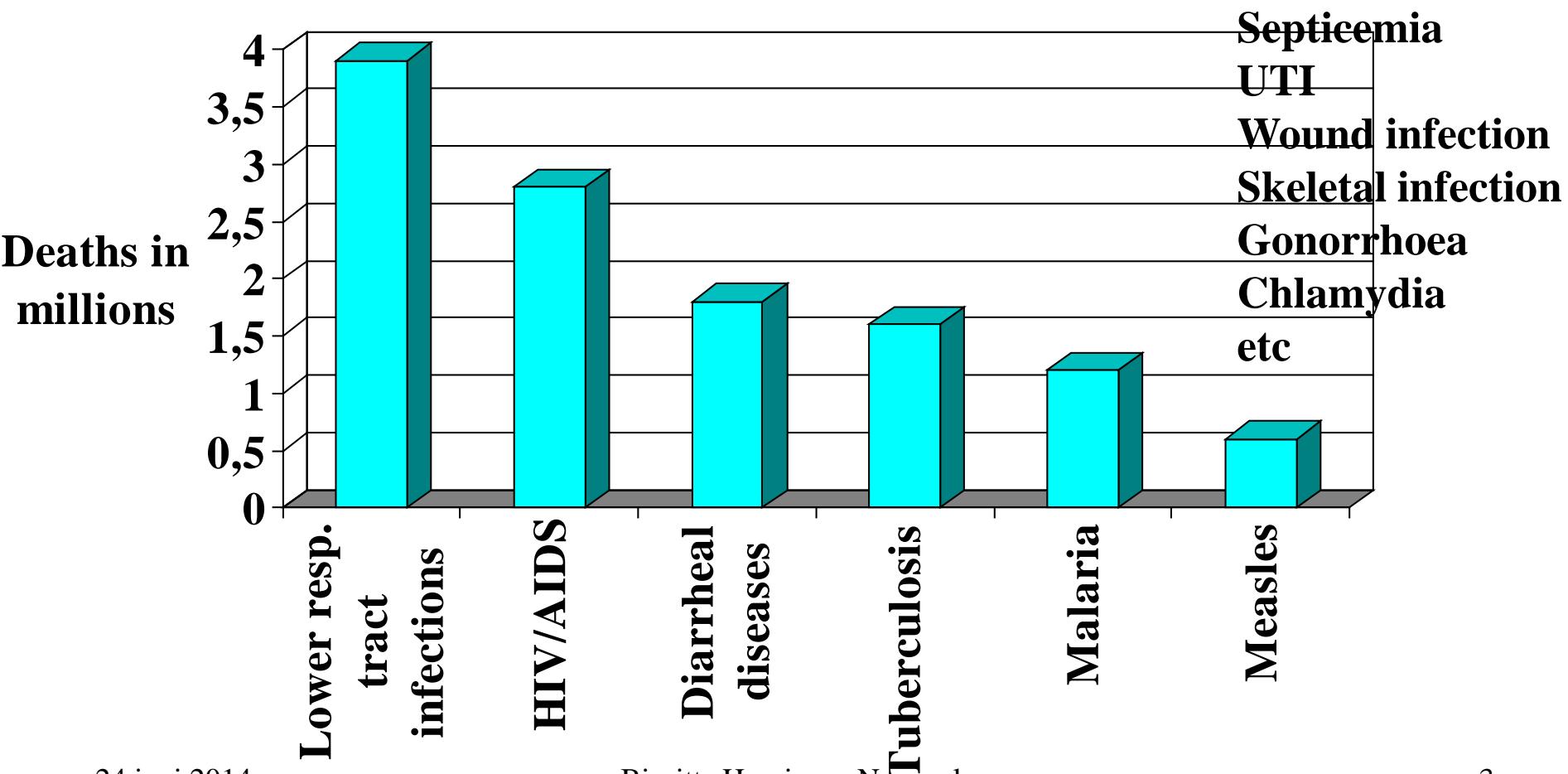
53.9 million from all causes, worldwide, 1998

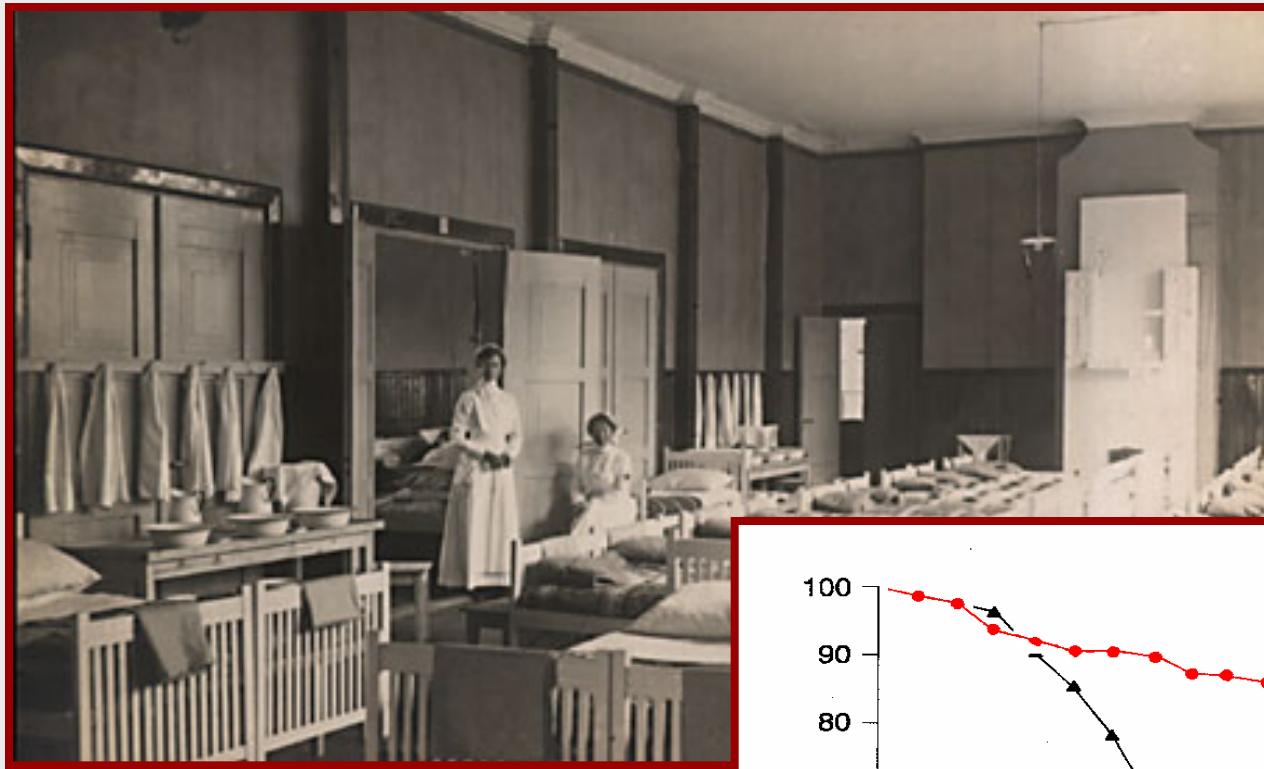


Note: Cancers, cardiovascular and respiratory/digestive deaths can also be caused by infections and raise the percentage of deaths due to infectious diseases even more.

Source: WHO 1999

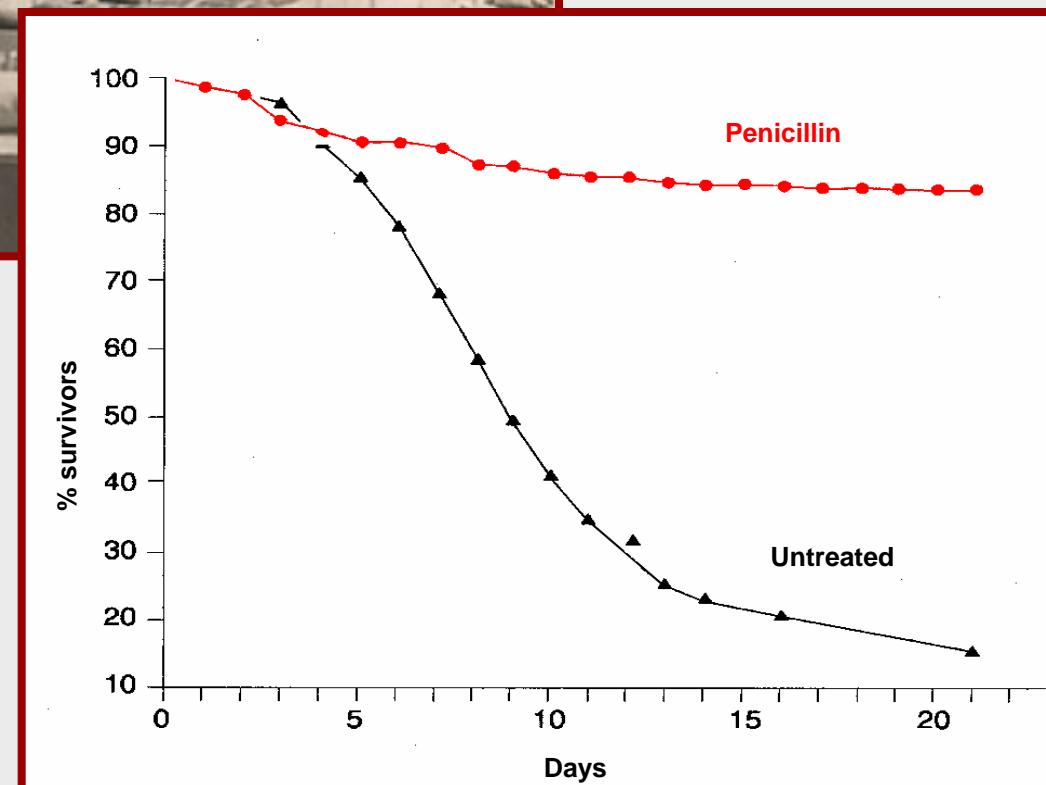
# Role of infectious diseases as cause of death worldwide in 2004





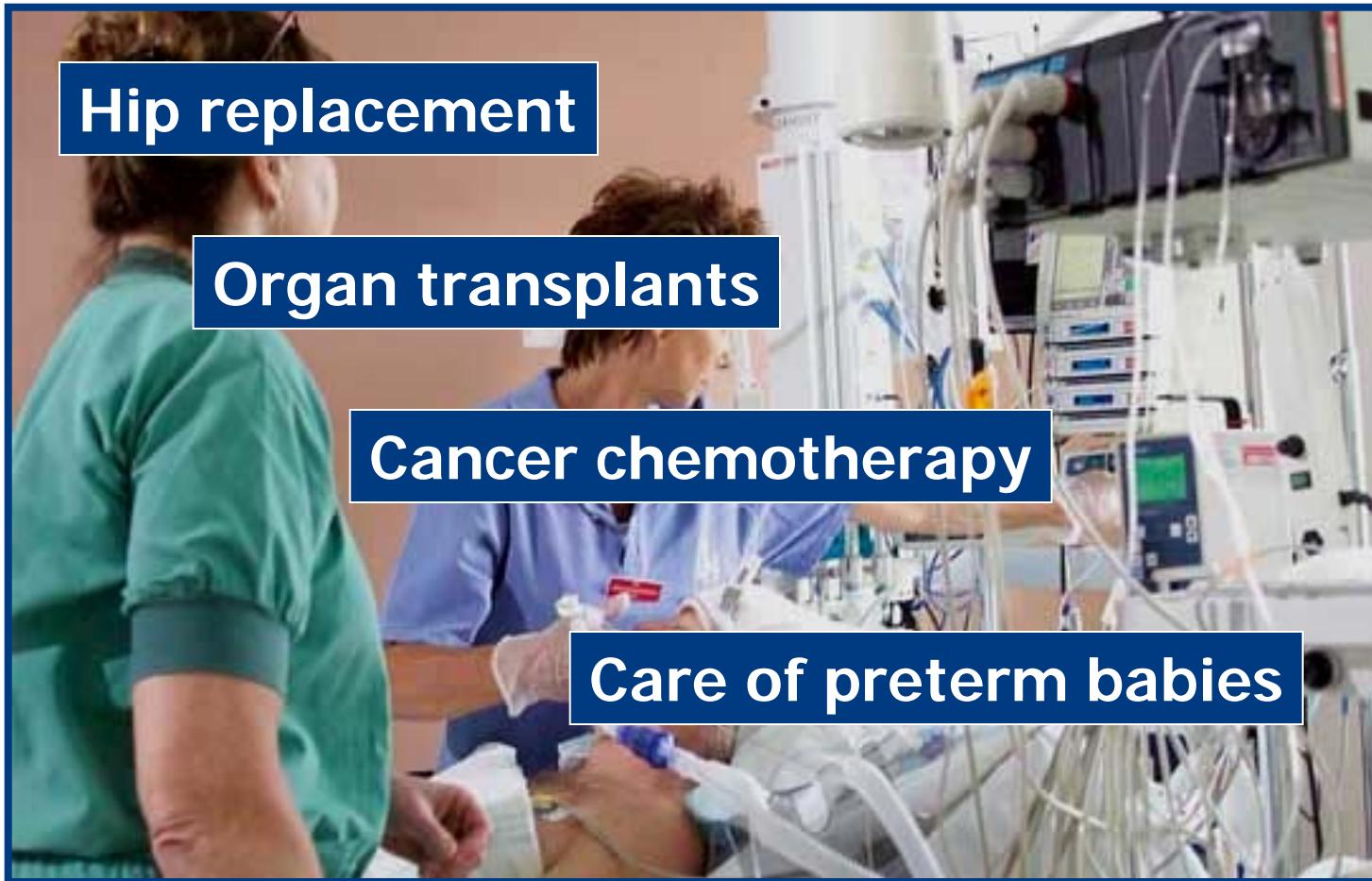
## Children with pneumonia and pneumococci in the blood

**Penicillin increased the chance of survival from 10% to 90%**



Adapted from Austrian *et al.*  
Ann. Int. Med. 1964; 60, 759  
24 juni 2014

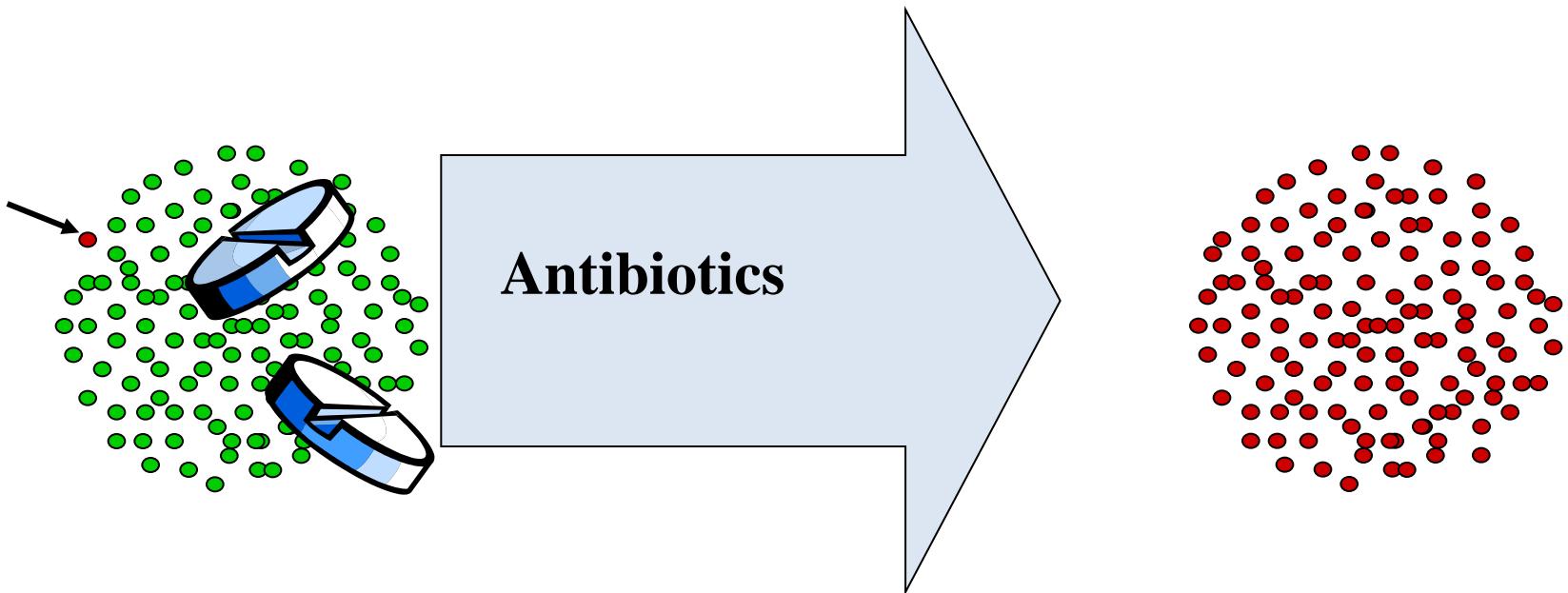
# Modern medicine is not possible without effective antibiotics



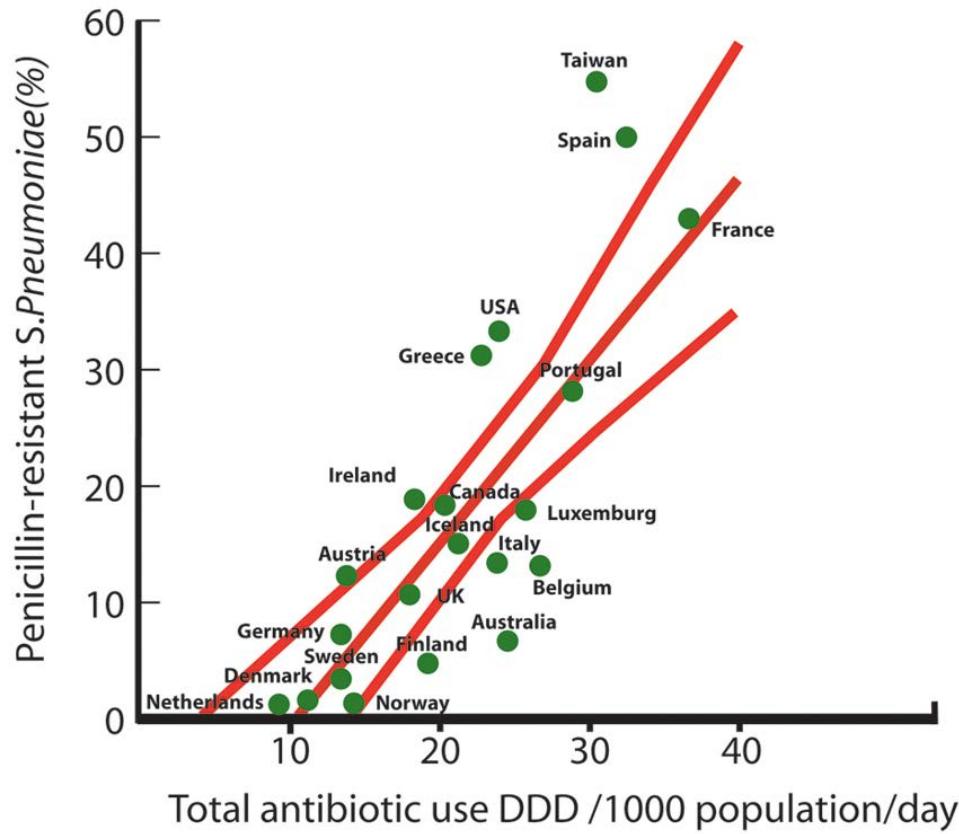
# Why emergence of antibiotic resistance?

- An indiscriminate use of antibiotics in both humans and animals
- Gene transfer between bacteria
- Rapid global spread of resistance
- Successful clones
- Poor sanitation and hygiene
- Alarming decline in drug development

# Use of antibiotics leads to selection of resistance



# Correlation between antibiotic use and resistance development



# Why emergence of antibiotic resistance?

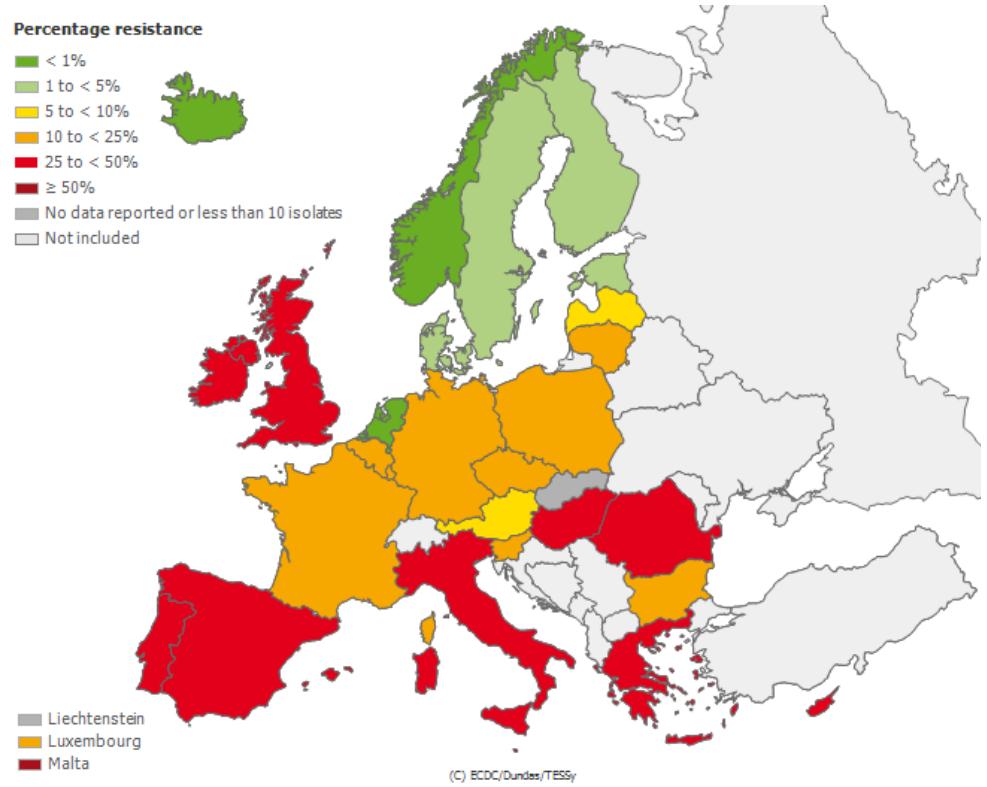
- An indiscriminate use of antibiotics in both humans and animals
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  - Successful clones (closely related bacteria)
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# Antibiotic resistance a global problem

MRSA in South America



MRSA in Europe

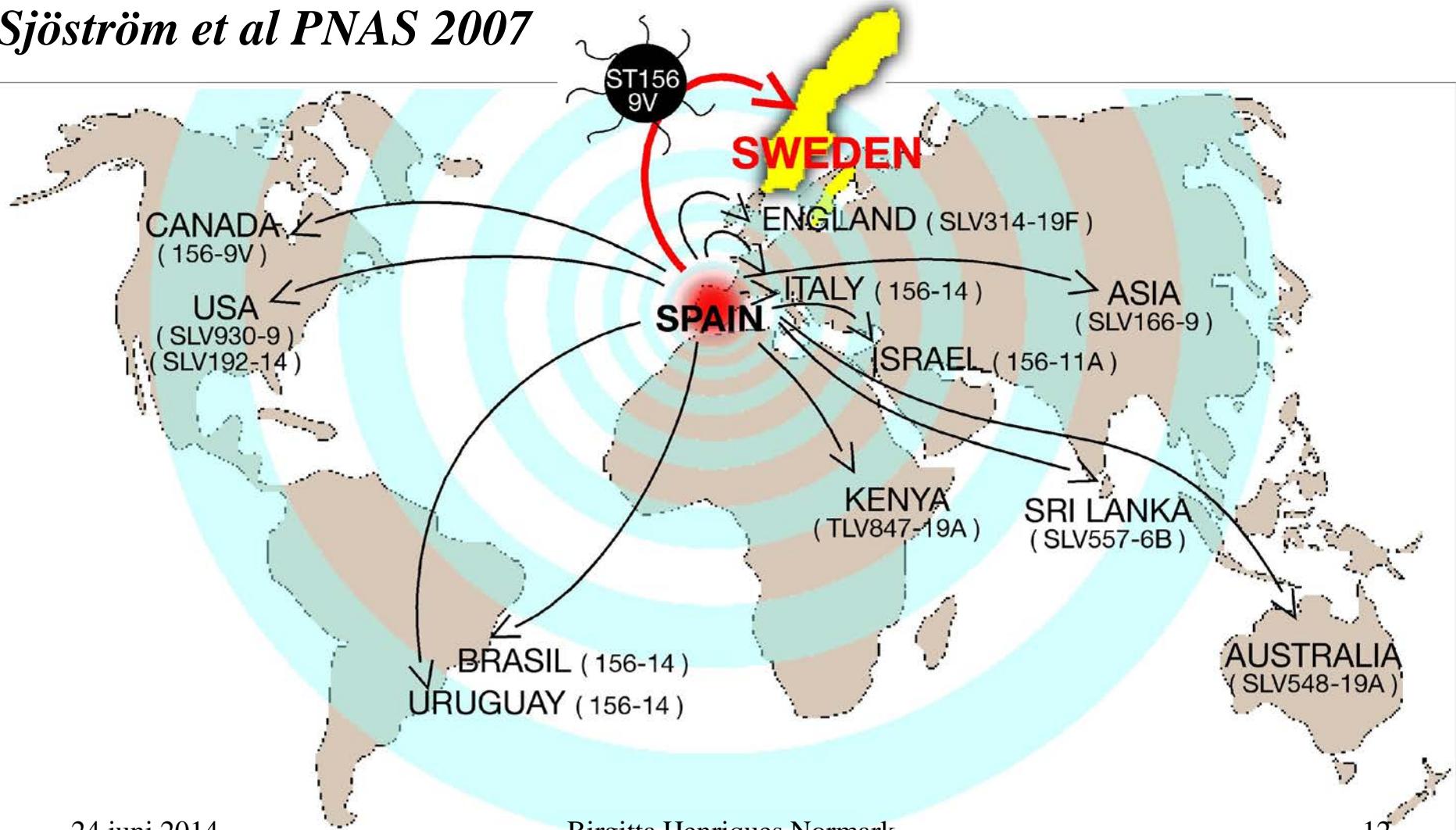


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# Bacterial factors important for global spread of antibiotic resistant pneumococci

*Sjöström et al PNAS 2007*



# Spread of NDM-1



# Why emergence of antibiotic resistance?

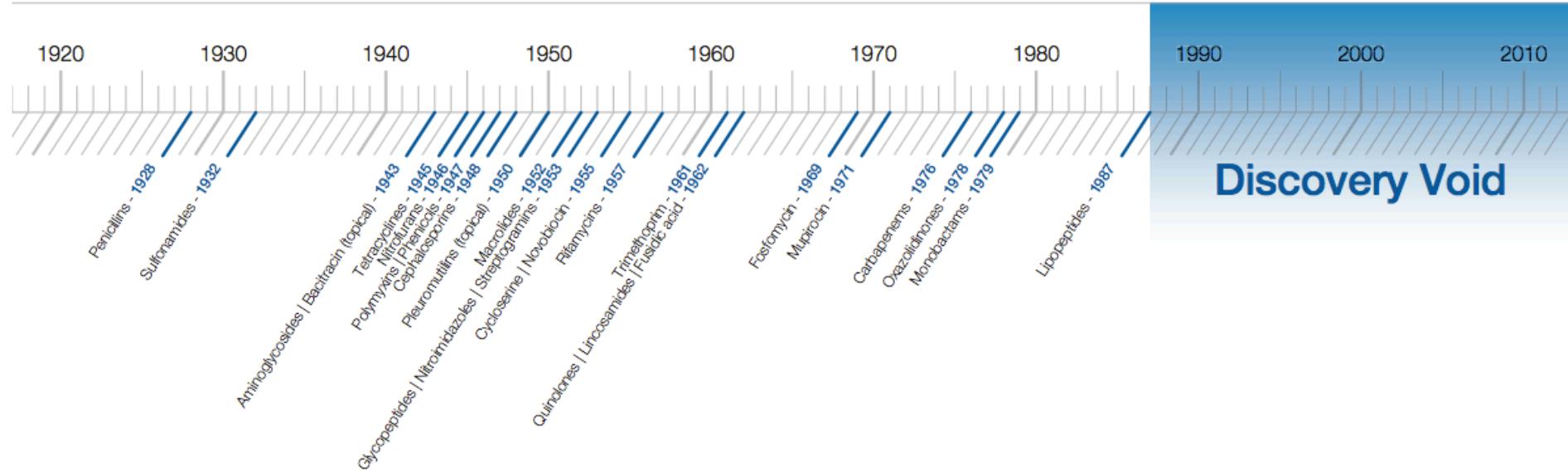
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# The antibiotic discovery void

The discovery dates of distinct classes of antibiotics. No new classes have been discovered since 1987.



From World Economic Forum  
Report (adapted from Silver, 2011)



# ~~Some strategies~~ to stop manage antibiotic resistance

Development of new antibiotics

Prolong the lifespan of existing drugs

- *Rational use, only when needed, rational use in animals, environment*

Better diagnostics

Prevent the spread of resistant bacteria

- *Improved hygiene*
- *Infection control*
- *Vaccines*



*Nom, nom, nom...*



# Thank you!

**Acknowledgment**  
**Karin Tegmark-Wisell**  
**Anna Zorzet**

