EG3246

SPATIAL SCIENCE & HEALTH

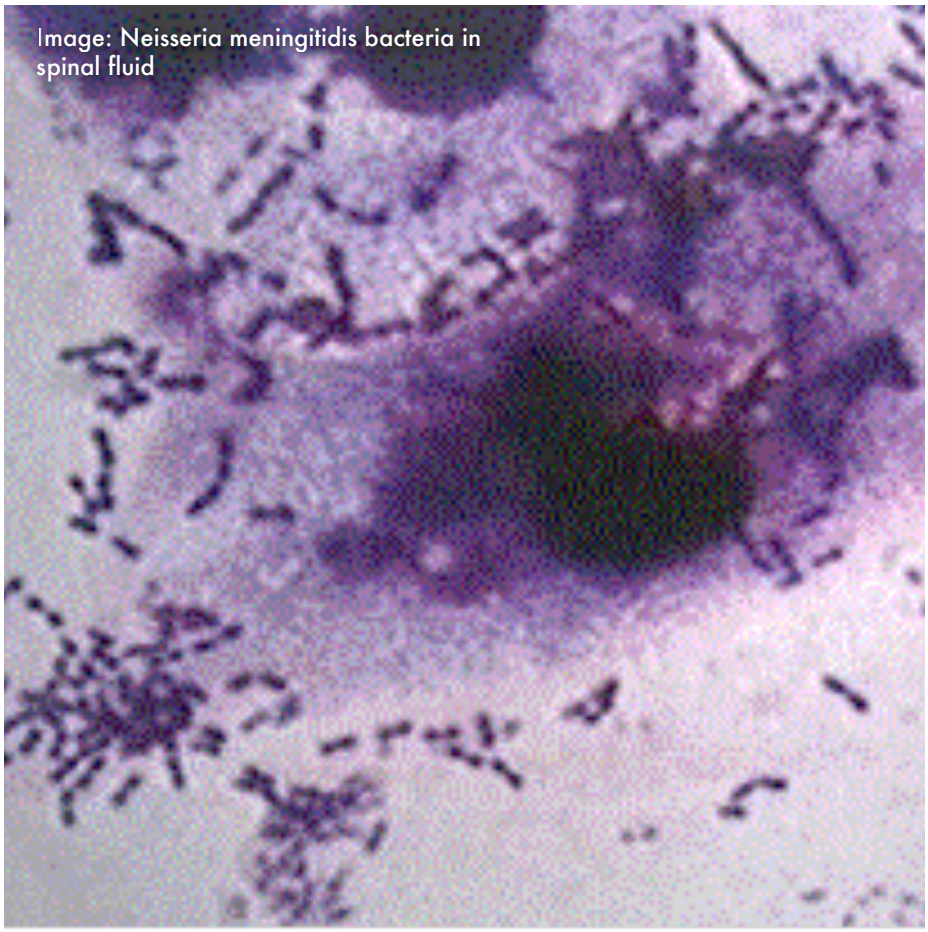

Image: Neisseria meningitidis bacteria in spinal fluid

Diseases have both spatial and temporal characteristics we can study....

Introduction to epidemiology

"Epidemiology is the study of the distribution and determinants of diseases within human populations. Research in this field is based primarily upon observing people directly in their natural environments."

Greenberg et al. 2005

"Epidemiology is the study of how often diseases occur in different groups of people, and why."

Stewart A. 2002 (after Coggon et al. 1997)

This unit is chosen primary to reflect the importance of epidemiology as an application of the geographical sciences. Epidemiology is a medical science – we are studying the application of spatial theory to it. Many of the ideas and theories expounded by geography (as a scientific discipline) lend itself to the world of medicine. Geography allows us to answer the following:

- Where do diseases occur?
- Are all members of a population equally susceptible to an illness?
- Where will a disease spread to?
- What might be causing epidemics of a disease?
- How should scarce resources be most effectively deployed?

In the past it has often been medics with a direct interest in geography who have been most successful in tackling these questions. Much of this has been in the realm of Tropical Medicine due to the influence of colonialism and the study of disease by military personnel.

Development of epidemiology has also come about by intense and inspired analysis of public health issues – such as the Cholera maps of London produced by Dr John Snow in 1831. (for more information about Snow, visit: http://www.ph.ucla.edu/epi/snow.html)

By no means have all diseases been cured. Even in the 21st Century there are wide range of diseases which inflict a low quality of life and untimely death to a large number of human beings each year. For these diseases (such as malaria) we can try and reduce their impact significantly by investing time and resources to study the epidemiology and hence intervention (prevention) strategies available.

Topics:

Please visit the unit WEBCT pages on a regular basis for additional support material and updates to the published teaching scheme....or go directly to:
http://www.ukscience.org

Mathematical & Statistical Ideas in Epidemiology

BIAS:

An undesirable feature of study design that tends to produce results which are systematically different from the real values (Stewart, 2002). Selection bias results from an incorrect population sampling procedure whilst information bias is due to incorrect data collection methods or data analysis such as data classification.

CONFOUNDING:

Confounding occurs when a separate factor (or factors) influences the risk of developing a disease, other than the risk factor being studied. To be a confounder, the factor has to be related to the exposure, and it also has to be an independent risk factor for the disease being studied. (Stewart, 2002).

INCIDENCE:

This is the number of new cases in a particular time period:

$$I = \frac{N}{P}$$

I = Incidence
N = Number of new cases in a given time period
P = Person years at risk during same time period

Note that person years at risk means the total amount of time (in years) that each member of the population being studied (the study population) is at risk of the disease during the period of interest.

PREVALENCE:

This is the proportion of current cases in a population at a given point in time:

$$P = \frac{Nc}{P}$$

P = Prevalence
Nc = Number of cases in the population at a given point in time
P = Total population at the same point in time

CRUDE RATES:

The crude rate refers to the number of occurrences for a whole population. It is usually expressed as a rate per 1000 members of the population but can be expressed as per 10,000 or 100,000

For example, to calculate the crude death rate, divide the number of deaths in a given time period by the number in the population in the same time period, and then multiply the result by 1000 (for rates per 1000).

ABSOLUTE RISK:

The probability of having a disease, for those individuals who were exposed to a risk factor.

$$Ra = \frac{Ne}{Ie}$$

Ra = Absolute Risk
Ne = Number of cases of disease in those exposed
Ie = Number of individuals exposed

RELATIVE RISK:

This is an indication of the risk of developing a disease in a group of people who were exposed to a risk factor, relative to a group who were not exposed to it.

$$RR = \frac{Ie}{In}$$

RR = Relative Risk
Ie = Disease incidence in exposed group
In = Disease incidence in non-exposed group

If RR=1, there is no association between the risk factor and the disease

If RR>1, there is an increased risk of developing the disease if one is exposed to the risk factor (eg. Disease=lung cancer; risk factor=smoking). It suggests that exposure to the risk factor may cause the disease.

If RR<1, there is a decreased risk of developing the disease if one is exposed to the risk factor (e.g. disease=colon cancer; risk factor=eating fresh fruit & veg). It suggests that exposure to the risk factor may protect against the disease.

IDEAS AND CONCEPTS: person, place and time

The first few affected patients identified with any outbreak of disease are referred to as sentinel cases.

A sudden and great increase in the occurrence of a disease within a population is referred to as an epidemic.

A rapidly emerging outbreak of a disease that affects a wide range of geographically distributed people is described as a pandemic

Patterns of disease occurrence are traditionally explored and characterised by the three dimensions of person, place and time. (All Greenberg et al, 2005)

MEDICAL RECORDS:

In order to perform spatial analysis of medical data we must have access to medical records. Due to the needs and constraints of medical ethics we often use anonymised data which means the actual identity of the person is kept confidential. A typical record might look like:

Characteristics of Sentinel Case	Person Attributes
Age	31
Gender	Male
Prior health	Good
Sexual preference	Homosexual
Place of occurrence	Los Angeles
Time of occurrence	October 19, 1980 to June 19, 1981

Characteristics of sentinel cases of AIDS in Los Angeles, 1981

In some cases we can improve the data relating to place by using GPS data for villages, clinics etc.

DISEASE SURVEILLANCE

A fundamental question we can ask about any disease is what the frequency with which the disease occurs is?

Active surveillance: this is where statistics relating to the frequency of a disease is actively compiled by teams investigating diagnosis at clinics and hospitals. This type of surveillance is more likely to spot an outbreak in its early stages so that some form of intervention can be administered. Financial costs can be high for this approach.

Passive surveillance: this is where knowledge of an outbreak of a disease is only noticed when a large number of cases are presented at a clinic or hospital. This type of surveillance will not usually spot the early stages of an outbreak and may not allow an effective intervention. Financial costs are very low.

READING LIST (BOOKS)

Greenberg R, Daniels S, Flanders W, Eley J and Boring J (2005). Medical Epidemiology. Fourth Edition, published by McGraw Hill. (ISBN: 0-07-141637-4)

Gilles H (1991). Management of severe and complicated malaria. Published by WHO, Geneva. (ISBN: 92-4-154436-8)

Gatrell A (2002). Geographies of health: an introduction. Published by Blackwell Publishing. (ISBN: 0-631-21985-4)

Stewart A (2002). Basic statistics and epidemiology: a practical guide. Published by Radcliffe. (ISBN: 1-85775-589-8)

Thomson M (1995). Disease prevention through vector control: guidelines for relief organisations. Published by Oxfam. Oxfam practical health guide No.10. (ISBN: 0-85598-306-X)

Pereira-Maxwell F (1998). A-Z of medical statistics: a companion for critical appraisal. Published by Arnold. (ISBN: 0-340-71940-0)

Hay S, Randolph S and Rogers D (2000). Remote sensing and geographical information systems in epidemiology. Published by Academic Press. (ISBN: 0-12-333560-4)

READING LIST

(Science Direct Sourced Journals)

- Accident Analysis & Prevention
- Annals of Epidemiology
- Comparative Immunology, Microbiology and Infectious Diseases
- Computational Statistics & Data Analysis
- Ecological Complexity
- Journal of Clinical Epidemiology
- Public Health
- Trends in Ecology & Evolution
- Trends in Parasitology

IMPORTANT ORGANISATIONS

WORLD HEALTH ORGANIZATION

The official and most authoritative organisation with responsibility for global, regional and even country-specific health related policies is the UN-WHO (http://www.who.int/en/).

The WHO regional office for Europe provides access to country-specific health and disease statistics via the centralized information system for infectious diseases (CISID). This is available from http://data.euro.who.int/cisid/.

The WHO regional office for the Western Pacific is http://www.wpro.who.int/

The WHO regional office for Africa is http://www.afro.who.int/

The WHO Roll Back Malaria (RBM) initiative http://www.emro.who.int/rbm/

Health for All database http://www.euro.who.int/hfadb

UK GOVERNMENTAL HEALTH STATISTICS

The UK Government provides a wide range of statistical health data. They publish a PDF report called the Health Statistics Quarterly in Feb, May, Aug and Nov. This is available from http://www.statistics.gov.uk/statbase/Product.asp?vlnk=6725&More=N

The NHS provides access to medical data via the Health & Social Care Information Centre available from http://www.hesonline.nhs.uk/Ease/servlet/DynamicPageBuild?siteID=1802&categoryID=192&callingCatID=325

Manchester-specific data is available from the Manchester City Council: http://www.manchester.gov.uk/health/jhu/intelligence/stats.htm

The World Resources Institute provides access to a wide range of country-specific information: http://earthtrends.wri.org/

TROPICAL DISEASES

The Liverpool School of Tropical Medicine: http://www.liv.ac.uk/lstm/

The London School of Hygiene & Tropical Medicine: http://www.lshtm.ac.uk/

MARA/ARMA (mapping malaria risk in Africa): http://www.mara.org.za/

Prince Leopold Institute of Tropical Medicine: http://www.itg.be/itg/GeneralSite/Generalpage.asp

Roll back malaria (RBM) partnership (WHO): http://www.rbm.who.int/cgi-bin/rbm/rbmportal/custom/rbm/home.do

Medicins sans Frontieres (MSF) http://www.msf.org/

International Committee of the Red Cross: http://www.icrc.org/

Department for International Development (DfID) – UK Government: http://www.dfid.gov.uk/

EMERGENCY MEDICAL RELIEF ORGANISATIONS

MERLIN: http://www.merlin.org.uk/

GIS/RS/EPIDEMIOLOGY SOFTWARE VENDORS

There are a number of software packages available for disease mapping, remote sensing and epidemiology. Some of these are free, some are commercial.

ESRI Arcview and ARCGIS (commercial): http://www.esri.com/

Clark Labs IDRISI (commercial): http://www.clarklabs.org/

Windisp (free): http://www.fao.org/giews/english/windisp/windisp.htm

EpiInfo (free): http://www.cdc.gov/epiinfo/

Various Links to Epidemiological Software: http://www.ehdp.com/vitalnet/episw.htm

BIBLIOGRAPHY

This reader document has included mathematical terms, algorithms, definitions, diagrams, tables and references from the following (course) texts:

Stewart A (2002). Basic statistics and epidemiology: a practical guide. Published by Radcliffe. (ISBN: 1-85775-589-8)

Greenberg R, Daniels S, Flanders W, Eley J and Boring J (2005). Medical Epidemiology. Fourth Edition, published by McGraw Hill. (ISBN: 0-07-141637-4)

GLOSSARY OF TERMS

$\pm$	Plus or minus
/	Divide by (same as '÷')
$\leq$	Less than or equal to
$\geq$	More than or equal to
$<$	Less than
$>$	More than
α	Type 1 error (or 'alpha error')
β	Type 2 error (or 'beta error')
AR	Attributable risk (or absolute risk)
ARR	Absolute risk reduction
CI or c.i.	Confidence interval
d.f.	Degrees of freedom
N or n	Sample size
NNT	Number needed to treat
NPV	Negative predictive value
OR	Odds ratio
P or p	Probability or significance value
p	Observed proportion
PAR	Population attributable risk
PPV	Positive predictive value
RCT	Randomised controlled trial
RR	Relative risk
s	Standard deviation for samples
SD or s.d.	Standard deviation
SE or s.e.	Standard error
SMR	Standardised mortality ratio
t	t-value (from the t-distribution)
z	Test statistic used in the normal test

ADDITIONAL IMPORTANT RESOURCES

HEALTHMAPPER: http://www.who.int/health_mapping/tools/healthmapper/en/

HEALTHMAP: http://www.healthmap.org/en

MALARIA ATLAS PROJECT: http://www.map.ox.ac.uk/

GLOBAL HEALTH ATLAS: http://www.who.int/globalatlas/

INT. J. of HEALTH GEOGRAPHIES: http://www.ij-healthgeographics.com/home/

WHO DATA & STATISTICS: http://www.who.int/research/en/