A short introduction to epidemiology

Chapter 1: Introduction

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Chapter 1

Introduction

• Germs and miasmas
• Risk factor epidemiology
• Epidemiology in the 21st century
# Public Health and Clinical Medicine

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Individuals</th>
<th>Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Medicine</td>
<td>Health services research</td>
</tr>
<tr>
<td>Prevention</td>
<td>Health education</td>
<td>Public health</td>
</tr>
</tbody>
</table>
Traditional Epidemiology

The study of the *distribution* and *determinants* of health-related states or events in specified *populations*, and the application of this study to control of health problems

*(Last, 1988)*
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## Snow on Cholera

<table>
<thead>
<tr>
<th>Water Supplier</th>
<th>Population</th>
<th>Deaths From Cholera</th>
<th>Death Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Southwark &amp; Vauxhall</td>
<td>167,654</td>
<td>844</td>
<td>5.0</td>
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<tr>
<td>Lambeth</td>
<td>19,133</td>
<td>18</td>
<td>0.9</td>
</tr>
<tr>
<td>Both</td>
<td>300,149</td>
<td>652</td>
<td>2.2</td>
</tr>
</tbody>
</table>
Snow’s Cholera Map
The Decline in Tuberculosis

Death rate

Year

Death rate

1855 1875 1895 1915 1935 1955
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Epidemiology Is a Population Science

• “Traditional” epidemiology starts at the population level and the first step is to ascertain variations in the occurrence of disease within and between populations
• “Populations” include not only countries, but geographical regions, demographic groups, communities, extended families, etc
Epidemiology Is a Population Science

- Many of the major discoveries in cancer epidemiology followed the publication of “Cancer Incidence in Five Continents” in the 1950s and 1960s which generated new hypotheses about possible (population and individual) causes of cancer.
- Of the 30-40 known occupational carcinogens, all were discovered in epidemiological studies and it often took many years of laboratory work to subsequently establish the etiologic mechanism.
Problems of the Risk Factor Approach: Tobacco

Ex-smokers
Current smokers

Class

%
Problems of the Risk Factor Approach: Tobacco

The limited success of legislative measures in industrialised countries has led the tobacco industry to shift its promotional activities to developing countries so that more people are exposed to tobacco smoke than ever before.

Thus, on a global basis the “achievement” of the public health movement has often been to move public health problems from rich countries to poor countries, and from rich populations within the industrialised countries.
Problems of the Risk Factor Approach: Tobacco

When a public health problem is studied in individual terms (e.g., tobacco smoking) rather than in population terms (e.g., tobacco production, advertising and distribution, and the social and economic influences on consumption) then it is very likely that the solution will also be defined in individual terms and the resulting public health action will merely move the problem rather than solve it.
OCCUPATIONAL CANCER
IN DEVELOPING COUNTRIES

EDITORS: N. PEARCE, E. MATOS, H. VAINIO,
P. BOFFETTA and M. KOGEVINAS

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N° 129
LYON 1994
Problems of the Risk Factor Approach: Asbestos

- Brazil
- Zimbabwe
- South Africa
- USSR
- Canada

Year:
- 1973
- 1981
- 1990

Tonnes (1,000s):
- 0
- 1000
- 2000
- 3000
- 4000
- 5000
Examples of the “Top Down” Approach

- Cancer Incidence in Five Continents
- Global comparisons of CDH
- Global comparisons of asthma prevalence
  - The European Community Respiratory Health Study (ECRHS)
  - The International Study of Asthma and Allergies in Childhood
ISAAC Steering Committee

 ISAAC 1998

R Anderson
(M Burr)
U Keil
D Strachan
E von Mutius
S Weiland
H Williams

B Björkstén

S Montefort

JR Shah

N Aït-Khaled
G Anabwani

I Asher (chair)
R Beasley
J Crane
E Mitchell
N Pearce
C Robertson

C Lai

S Foliaki

(F Martinez)

J Mallol
<table>
<thead>
<tr>
<th>Region</th>
<th>Centre</th>
<th>Participants</th>
<th>Participation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Africa</td>
<td>10</td>
<td>31,007</td>
<td>93%</td>
</tr>
<tr>
<td>Asia-Pacific</td>
<td>35</td>
<td>103,818</td>
<td>94%</td>
</tr>
<tr>
<td>Eastern/Northern</td>
<td>17</td>
<td>57,300</td>
<td>90%</td>
</tr>
<tr>
<td>Europe</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eastern Mediterranean</td>
<td>10</td>
<td>27,460</td>
<td>92%</td>
</tr>
<tr>
<td>Latin America</td>
<td>16</td>
<td>46,545</td>
<td>93%</td>
</tr>
<tr>
<td>North America</td>
<td>5</td>
<td>12,460</td>
<td>81%</td>
</tr>
<tr>
<td>Oceania</td>
<td>10</td>
<td>31,311</td>
<td>91%</td>
</tr>
<tr>
<td>Western Europe</td>
<td>51</td>
<td>132,998</td>
<td>84%</td>
</tr>
<tr>
<td><strong>Global Total:</strong></td>
<td>155</td>
<td><strong>463,801</strong></td>
<td><strong>92%</strong></td>
</tr>
</tbody>
</table>
12 Month Period Prevalence of Asthma Symptoms in 13-14 Yr Old Children
Key Findings From ISAAC

• English-speaking countries have the highest asthma prevalence in the world
• There is little variation within the English-speaking countries
• Other countries in Latin America are also high
• There is a Northwest-Southeast gradient within Europe
Key Findings From ISAAC

• There is an inconsistent correlation of asthma prevalence with affluence (as measured by GNP)
• There are some areas (West/East Germany, Hong Kong/Guangzhou) with major prevalence differences within the same ethnic group
• There is a weak and inconsistent association between asthma prevalence and that of other “atopic” conditions such as rhinitis and eczema
Levels of Analysis: “Top-down” Versus “Bottom-up”

- Populations
- Groups
- Individuals
- Organs
- Cells
- Molecules

- Social science/epidemiology
- Clinical
- Pathology/biology
- Molecular biology
The “top down” (population) approach

- Health can be studied at many levels (molecular, individual, population, and ecosystem)
- Each of these levels are important
- The population and ecosystem levels are fundamental because they define the public health problems to be addressed
- They also provide a “reality check” on findings from molecular-level and individual-level studies
The Decline of Population Epidemiology

There is currently little interest in the population approach because:

- It is regarded as “too political”, “old fashioned” and uninteresting
- There is a lack of support and funding
- The rise of molecular biology and the human genome project
“Modern” Epidemiology

“The study of the occurrence of illness”

“A systematic body of epidemiologic principles by which to design and judge [epidemiologic] studies has begun to form only in the last two decades”

(Rothman, 1986)
“Modern Epidemiology”

- Epidemiology is a generic method
- The word “populations” is not necessary for its definition
- The focus is on measuring individual exposure-disease associations
- Certain study designs are most valid
- We should focus on hypotheses that fit these study designs
“Modern” Epidemiology

• Concentrates on studying individual “risk factors” for disease
• “Clinical trial” paradigm comparing “exposed” with “non-exposed” individuals
• Emphasis on “analytical” rather than “descriptive” studies
• Emphasis on individuals rather than populations
• Increasing emphasis on molecular biology and biomarkers
The “Bottom Up” Approach

- Reductionist
- Positivist
- Focuses on understanding the individual components of a process at the lowest possible level and using this information as the “building blocks” to gain knowledge about higher levels
- “A vast stockpile of almost surgically clean data untouched by human thought”
Problems of “Modern” Epidemiology

Epidemiology has largely ceased to function as part of a multidisciplinary approach to understanding the causation of disease in populations and has become a set of generic methods for measuring associations of exposure (“risk factors”) and disease in individuals.

If epidemiology is just about measurement then it can never claim to be a science.
Recent changes in the epidemiologic paradigm have changed, and have reflected changes in, the way in which epidemiologists think about health and disease.

The key issue has been the shift in the level of analysis from the population to the individual.
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Epidemiology in the 21st century

• The importance of context
• Problem-based epidemiology
• Living with complexity
• Appropriate technology
The Importance of Context

The “populations” which epidemiologists study are not just collections of individuals which are conveniently grouped for the purposes of study, but are instead historical entities.

Every population has its own history, culture, organisation, and economic and social divisions which influences how and why people are exposed to particular factors, and how they respond.
The Importance of Context

• There were large numbers of deaths amongst the indigenous people when New Zealand (Aotearoa) and other areas of the Pacific were colonised in the 19th century
• It is commonly assumed that these deaths were due to infectious diseases, and affected all populations
• In fact, many populations experienced very few deaths
• The main determinant of death from infectious disease was whether land was taken (and therefore the social systems disrupted)
Problem-based Epidemiology

• The approach of “problem-based” medicine can be used in the teaching and practice of epidemiology

• The appropriate methods should be chosen to fit the problem rather than letting the methods define the problem
Living with complexity

• E.g. studies of the effects of climate change on the spread of malaria
  – Models based on human-biting rate of mosquitoes, human susceptibility, mosquito susceptibility, daily survival probably of the mosquito, and incubation period of the parasite (depends on temperature, rainfall, etc)
Living with complexity

• Involves quite different methods from the usual epidemiologic techniques (you can’t do a cohort study of climate change unless you have two planets)
• Requires a “systems based” (complexity) approach
• Complexity theory is influencing many fields of science (physics, chemistry, geography, biology, neuroscience, economics, etc) but has had little influence on the theory and practice of epidemiology to date
Living with complexity

• Integrates information from several fields of research
• Involves non-linearity and “feedback loops”
• What is “chaotic” at one level may be “simple” at another (we can’t predict population health from molecular biology any more than we can predict the weather from the movements of individual molecules)
Appropriate technology

- The appropriate methods should be chosen to fit the public health problem
- It cannot be simply assumed that high-tech methods such as "molecular epidemiology" will be the most valid
- Just as case-control studies were developed for "risk factor" epidemiology, new methods need to be developed for "ecoepidemiology"
- In many instances a "complexity" or "systems approach" is required
Epidemiology As a Population Science

• The current danger for epidemiology is not the use of new techniques or micro-level analyses, but that these techniques may define which hypotheses are acceptable for study
“Postmodern” Epidemiology

Susser suggests that epidemiology has been through three major phases and is now entering a fourth:

- *miasma theory epidemiology* ("traditional")
- *germ theory epidemiology* ("traditional")
- "black box” epidemiology ("modern”, “risk factor”)
- *global epidemiology*
Epidemiology in the 12st century

• We need to reintegrate epidemiology into public health and restore the population perspective
• This requires not just multi-level analysis but rather “multi-level thinking”
• This multi-level thinking can be encouraged and fostered by a problem-based approach which recognises the complex population context and uses appropriate technology to study it
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