Epidemiology: An Overview

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Epidemiology Presentations

What is epidemiology? What sciences does it draw from? How is it demarcated?

What are its uses?

What are its basic concepts?

What are its modern applications?

What are good references?
Epidemiology Presentations

- Overview (AM)
- Causal inference (AM)
- Study designs (AM)
- Sources of epidemiological data (KR)
- Measurements in epidemiology (KR)
- Sources of measurement error (KR)
What is Epidemiology?
Demarcation of Epidemiology

- Demarcation of scientific disciplines evolves historically as their intellectual, institutional and professional environments evolved.
- Epidemiology benefits from a rich plurality of scientific cultures and practices; consequently it enjoys diverse demarcation discourses, with diverse applications in public health policy, clinical practice, basic research....
- IEA book: Development of modern epidemiology
Classically speaking

- Epi = upon
- Demos = people
- Ology = science
- Epidemiology = the science which deals with what falls upon people.....
- Bridge between biomedical, social and behavioral sciences
Simple Old Definitions

Oxford English Dictionary

THE BRANCH OF MEDICAL SCIENCE WHICH TREATS EPIDEMICS

Kuller LH: American J of Epidemiology 1991;134:1051

EPIDEMIOLOGY IS THE STUDY OF "EPIDEMICS" AND THEIR PREVENTION

Anderson G. In: Rothman KJ: Modern Epidemiology

THE STUDY OF THE OCCURRENCE OF ILLNESS
A Modern Definition

Study of the occurrence and distribution of health-related diseases or events in specified populations, including the study of the determinants influencing such states, and the application of this knowledge to control the health problem

(Porta M, Last J, Greenland S. A Dictionary of Epidemiology, 2008)
Who is an epidemiologist?

A professional who strives to study and control the factors that influence the occurrence of disease or health-related conditions and events in specified populations and societies, has an experience in population thinking and epidemiologic methods, and is knowledgeable about public health and causal inference in health

(Porta M, Last J, Greenland S. A Dictionary of Epidemiology, 2008)
Epidemiologists are required to have some knowledge of:

- **Public health**: because of the emphasis on disease prevention

- **Clinical medicine**: because of the emphasis on disease classification and diagnosis *(numerators)*

- **Pathophysiology**: because of the need to understand basic biological mechanisms in disease *(natural history)*

- **Biostatistics**: because of the need to quantify disease frequency and its relationships to antecedents *(denominators, testing hypotheses)*

- **Social sciences**: because of the need to understand the social context in which disease occurs and presents *(social determinants of health phenomena)*
Purposes of Epidemiology

1. To investigate nature / extent of health-related phenomena in the community / identify priorities
2. To study natural history and prognosis of health-related problems
3. To identify causes and risk factors
4. To recommend / assist in application of / evaluate best interventions (preventive and therapeutic measures)
5. To provide foundation for public policy
Classical versus Modern Applications

- **Classical**: descriptive, observational, field, analytical, experimental, applied, healthcare, primary care, hospital, CD, NCD, environmental, occupational, psycho-social, etc

- **Modern**: risk-factor, molecular, genetic, life-course, CVD, nutritional, cancer, disaster, etc
"My question is: Are we making an impact?"
Broad Types of Epidemiology

**DESCRIPTIVE EPI**

Examining the distribution of a disease in a population, and observing the basic features of its distribution in terms of time, place, and person. We try to formulate hypothesis, look into associations?

Typical study design: community health survey (synonyms: cross-sectional study, descriptive study)

**ANALYTIC EPI**

Testing a specific hypothesis about the relationship of a disease to a specific cause, by conducting an epidemiologic study that relates the exposure of interest to the outcome of interest (? Cause-effect relationship)

Typical study designs: cohort, case-control, experimental design
Descriptive Epidemiology Is A Necessary Antecedent of Analytic Epidemiology

To undertake an analytic epidemiologic study you must first:

- Know where to look
- Know what to control for
- Be able to formulate / test hypotheses compatible with a-priori lab / field evidence
Basic Triad of Descriptive Epidemiology

THE THREE ESSENTIAL CHARACTERISTICS OF DISEASE WE LOOK FOR IN DESCRIPTIVE EPIDEMIOLOGY ARE:

- PERSON
- PLACE
- TIME
Personal Characteristics (whom)

- Age
- Gender
- Socio-economic status (education, occupation, income)
- Marital status
- Ethnicity/race/genetic profile
- Behavior / habits
Place (where ?)

- Geographically restricted or widespread (outbreak, epidemic, pandemic)? Off-shore (tsunami...)
- Climate effects (temperature, humidity, combined effects..)
- Urban / sub-urban-squatter / rural
- Relation to environmental exposure (water, food supply, etc)
- Multiple clusters or one?
Time (when ?)

- Changing or stable?
- Clustered (epidemic) or evenly distributed (endemic)?
- Time-trends: Point source, propagated, seasonal, secular, combinations
What designs do epidemiologists use?

- Qualitative designs
- Quantitative designs
  - Observational
  - Experimental
- Building evidence
What measures do epidemiologists use?

- Frequency measures
- Effect measures
- Impact fractions
Among Unique Skills of Epidemiologists:

MEASURING DISEASE FREQUENCY IN POPULATIONS
Measuring Disease Frequency Has Several Components

- Classifying and categorizing disease
- Deciding what constitutes a case of disease in a study
- Finding a source for ascertaining the cases
- Defining the population at risk of disease
- Defining the period of time of risk of disease
- Obtaining permission to study people
- Making measurements of disease frequency
- Relating cases to population and time at risk
Basic triad of analytical epidemiology

THE THREE PHENOMENA ASSESSED IN ANALYTIC EPIDEMIOLOGY ARE:

HOST

AGENT

ENVIRONMENT
Agents

- **Biological** (micro-organisms)
- **Physical** (temperature, radiation, trauma, others)
- **Chemical** (acids, alkalis, poisons, tobacco, others)
- **Environmental** (nutrients in diet, allergens, others)
- **Psychological** experiences
Host Factors

- Genetic endowment
- Immunologic status
- Personal characteristics
- Personal behavior
- Definitive versus intermediate (in vector-borne diseases)
Environment

- Living conditions (housing, crowding, water supply, refuse, sewage, etc)
- Atmosphere / climate
- Modes of communication: phenomena in the environment that bring host and agent together, such as: vector, vehicle, reservoir, etc)
Does epidemiology assist in problem-solving in health-related policy-making?
Epidemiology goes Popperian

As a scientific discipline, epidemiology is liberating because it does not accept dogma. It has helped liberate the practice of public health and medicine from dogmatic thinking over the past century.

Popperian thinking in epidemiology:
- Refutation of the existing way of thinking
- A hypothesis can never be proven. However, there are hypotheses that have never been rejected ...so far
Epidemiology as a problem solving discipline: Integrating principles

The first integrating principle is that epidemiology is an information science.

The second integrating principle is that epidemiology operates within an environment of complex systems.

Third integrating principle is that epidemiology is not just a scientific discipline but a professional practice area.
(I) Epidemiology is an information science

Epidemiology is an *information science*: Data generated by epidemiologists is to be used for *decision making*.

Epidemiology is *purposive*: methods and knowledge are to be used for the ultimate purpose of *prevention of disease, disability and death*.

Epidemiology is under *public scrutiny*. Information affects decisions at the *public policy* level, at the level of *individuals*, and by *health professionals*. A *social responsibility*. 
INFORMATION $\rightarrow$ DECISION $\rightarrow$ ACTION
GENERATION $\rightarrow$ PROCESS

EPIDEMIOLOGIC $\rightarrow$ PROCESS OF $\rightarrow$ INTERVENTION
METHODS $\rightarrow$ INFERENCES
Epidemiology assists:

- **Systems**: information, surveillance
- **Decisions**: political, management
Information Systems: Value and Quality

1. Timeliness
2. Quantity
3. Frequency
4. Use for Decision Making
5. Presence of Feedback Loop
Surveillance Systems: Evaluation

1. Sensitivity
2. Predictive value positive
3. Simplicity
4. Flexibility
5. Acceptability
6. Representativeness
7. Timeliness
8. Reliability or precision
Political Decisions

- Budget and Resource Allocation
- Jurisdiction of agencies
- Personnel selection
- Legislation
Management Decisions

- Efficacy – Patient Care
- Effectiveness – Public Health
- Compliance
- Quality Assurance
- Training
- Planning
- Programming
In a health-system, epidemiology supports:

- Structure
- Process
- Outcome
How does this work?

**Structure:** Does a structure exist to implement the health care intervention (program) and what are its characteristics?

**Process:** Is the process to implement the health care intervention (program) working?

**Outcome:** What effect has the intervention had on the outcome(s) of interest?
What outcomes?

**Mortality:** all cause / cause-specific

**Morbidity**
- Disease-specific indicators / General indicators: clinic use, hospitalization, medication use

**Quality of life**
- General / Disease-specific

**Costs**
This week I developed what I call "process pride."

Obviously I can't take pride in the results of my work. Obviously.

So I learned to take pride in my processes instead of my results.

Everything I do is still pointless, but I'm very proud of the way I do it.
(II) Epidemiology operates within complex systems.

Our etiologic investigations continue to have a focus of simple models even if we use multivariate analyses.

Etiologic factors operate in complex systems and we need to consider the use of a systems analysis approach in investigating etiology. Epidemiologists, need to work at multiple levels to make the appropriate inferences.

“As a physician working in this health center I am not just interested in the trends and distribution of the disease but I want first to know individually who are my diabetic patients and what is being done to them”
CLASSIC EPIDEMIOLOGIC RESEARCH INTO ETIOLOGY

Environmental factor(s) → Outcome
CLASSIC EPIDEMIOLOGIC RESEARCH INTO ETIOLOGY

Other factors including health care

Environmental Factor(s)

Outcome
CLASSIC HEALTH SERVICES
RESEARCH INTO EFFECTIVENESS
CLASSIC HEALTH SERVICES
RESEARCH INTO EFFECTIVENESS

Environmental and other factors

Health Care

Outcome
(III) Epidemiology is a professional practice area

John Racy defined a profession as “a socially sanctioned activity whose primary object is the well-being of others above the professional’s personal gain”

Epidemiology:
- a solid disciplinary scientific base
- requires well grounded academic preparation
- objectives within the public-social domain
- uses well defined paradigms of problem investigation, analysis, and inferences.
From the Present to the Future 1

Science is universal but we each bring to it our own way of thinking and the wealth of experience and heritage for some common goal.

When we are inspired and driven by the potential impact of what we can achieve, then we can make a great leap forward for the discipline.
From the Present to the Future 2

Henry Siegerist: one of the problems of medicine through the ages has been that technology has always outpaced sociology.

Epidemiology is in need of sociology more than additional technology. Sociology in epidemiology is in the context of its uses and its practice within the framework of health services.
From the Present to the Future 3

Human beings are not just a collection of cells or molecules but also have spirituality that binds the molecules and cells with an integrative purpose and the resultant direction. Thus, in every culture and with every individual there is this search for dignity that elevates us out of our biological complexity.

Public health action, problem solving and a sense of mission is what brings many of our students to health sciences and epidemiology.
Pierre Teilhard de Chardin mentioned that:

In the final analysis, the questions of why bad things happen to good people transmutes itself into some very different questions, no longer asking why something happened, but asking how we will respond, what we intend to do now that it happened.

It is our duty as men and women to proceed as though the limits of our abilities do not exist.

We are not human beings having a spiritual experience. We are spiritual beings having a human experience.

We are one, after all, you and I. Together we suffer, together exist, and forever will recreate each other.
References

- Paneth N. *Introduction to epidemiology*. Michigan State University, USA.
Websites

- World Health Organization: www.who.int
- Centers for Disease Control and Prevention: www.cdc.gov
- Epidemiology Supercourse: www.pitt.edu/~super1/
- International Epidemiological Association: www.IEAWeb.org
- Oxford University Press: www.oup.org
- Email address: ahmed.mandil@yahoo.com
Thank you for your kind attention