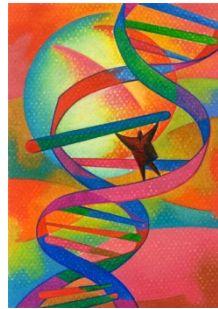


Genomics and Public Health



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Definitions

- Genetics is the study of individual genes
- Genes are sequences of DNA, at specific positions on chromosomes
 - They provide critical codes that translate into proteins
- Mutation is a change in the sequence of DNA
- Genomics is the interaction of **all** genes and environmental factors

Role of Genes in Diseases

- Autosomal Recessive (contained in chromosome pairs 1 through 22)
- Autosomal Dominant
- X-Linked (contained in the sex chromosome)
- Mitochondrial Inheritance

Multifactoral Risks

- Health, growth and development include environmental component
- Chemical exposure and the internal environment of body can affect risk of deletions
 - DNA mutations can be spontaneous, or caused by chemicals, viruses, or radiation

Common Diseases With a Confirmed Genetic Component

- Hypertension
- Diabetes Mellitus I II
- Alzheimer Disease
- Cardiovascular disease
- Cancer
- Osteoporosis
- Psoriasis
- Glaucoma
- Age-related Hearing Loss
- Schizophrenia
- Bipolar Disease
- Depression
- **All Disease (with the Possible Exception of Trauma) is Genetic.**

Two Categories

1. Common gene / Moderate risk

- Genes that are very common in the general population (30-50%) but only increase the risk moderately and almost always require environmental factors and other genes
- ApoE Alzheimer
- Factor V Leiden Stroke / Clotting
- CCR5 HIV/AIDS resistance

2. Rare gene / High risk

- Gene frequency usually less than 10% but risk for disease can be greater than 50%
- HNPCC Colon Cancer
- BRCA 1 and 2 Breast Cancer
- MODY 1,2,3 Diabetes
- Alpha-synuclein Parkinson Disease

Why GENOMICS not Genetics

- Genomics is a new evolving term

Genomics and Public Health

- Human diseases result from gene-environment interaction
- Public health leadership needed to translate gene discoveries
- Genetics affects all public health functions: assessment, policy development and assurance
- Public health must plan to train the workforce in order to build genetics capacity across programs

The “Old Genetics”

- About conditions wholly caused by:
 - An extra or missing chromosome or part of a chromosome
 - A mutation in a single gene
- These conditions
 - Are of great importance to individuals and families with them
 - But, even when added together, are relatively rare
 - Most people not directly affected
 - Genetics thus played relatively small role in health care (and in society)

The “Old Genetics”

- These conditions are rare enough that:
 - Genetics care could be supplied primarily by medical geneticists and genetic counselors, with occasional involvement of primary care providers and other specialists
- In terms of research:
 - Because of their small impact on health, these genetic conditions of relatively limited interest
 - In past two decades, genetics of relatively little help in answering basic questions, but of increasing help as source of lab tools

≥ 9 of the CDC's 10 Leading Causes of U.S. Deaths Have Genetic Components

1. Heart disease (31.0% of deaths in '98)
2. Cancer (23.2%)
3. Stroke (6.8%)
4. COPD (4.8%)
5. Injury (4.2%)
6. Pneumonia/Influenza (3.9%)
7. Diabetes (2.8%)
8. Suicide (1.3%)
9. Kidney disease (1.1%)
10. Chronic liver disease (1.1%)

≥ 9 of the WHO's 10 Leading Causes of Global Deaths Have Genetic Components

1. Heart disease (13.7% of total in '98)
2. Stroke (9.5%)
3. Pneumonia (6.4%)
4. HIV/AIDS (4.2%)
5. COPD (4.2%)
6. Diarrhea (4.1%)
7. Perinatal (4.0%)
8. Tuberculosis (2.8%)
9. Trachea/bronchus/lung cancer (2.3%)
10. Traffic accidents (2.2%)

The “New Genetics” - Genomics

- Comes largely from knowledge emanating from the Human Genome Project

Genomic Medicine

- About conditions partly:
 - Caused by mutation(s) in gene(s)
 - e.g., colon cancer, breast cancer, atherosclerosis, inflammatory bowel disease, diabetes, Alzheimer disease, mood disorders, many others
 - *Prevented* by mutation(s) in gene(s)
 - e.g., HIV (CCR5), ?atherosclerosis, ?cancers, ?diabetes, many others

Genomic Medicine

- These conditions
 - Are also of great importance to individuals and families with them
 - But are quite common
 - Directly affect virtually everyone
 - Will make genetics play large role in health care and in society
- In terms of research:
 - Because of their great impact on health, these conditions are of great interest
 - In next two decades, genetics will provide not only even better lab tools, but also answers to many basic biological questions

Genomic Medicine

- So, much more to come, in the next few years, as these genetic contributions to more common disease are identified...

Genomic Medicine

- Knowledge of individual genetic predispositions will allow:
 - Individualized screening,
 - Individualized behavior changes
 - Presymptomatic medical therapies, e.g., anti-colon cancer agents before colon cancer develops, antihypertensives before hypertension develops

The Human Genome Project

- An international government project that is ahead of schedule!
- And under budget!!
- And from its start has earmarked funds for consideration of its ethical, legal, and social implications (ELSI) - the largest funding ever devoted to bioethics!!!

Human Genome Project

future impact

- Understand biological basis of diseases
- Predict disease susceptibility before symptoms
- Interventions targeted to disease biology
- Pharmacotherapy
- Individualized prevention – *“Individually Sized”*

Applications of genetic knowledge in medical practice

Pharmacogenomics

- The study of how an individual's genetic inheritance affects the body's response to drugs
 - by combining traditional pharmaceutical sciences with annotated knowledge of genes, proteins, and single nucleotide polymorphisms (DNA sequence variations)

Pharmacogenomics will allow:

- individualized medication use based on genetically determined variation in effects and side effects
- use of medications otherwise rejected because of side effects
- new medications for specific genotypic disease subtypes

Genetic Testing

- DNA-based tests examine the DNA molecule itself
- Obtained from any tissue, or from blood
 - Biochemical tests examine enzymes and other proteins
 - Microscopic examinations look at stained or fluorescent chromosomes
 - Pre-implantation genetic diagnosis (PGD) screens for genetic flaws among embryos used in vitro fertilization

Pros of Genetic Testing

- Genetic testing can clarify diagnosis and enable appropriate treatments (e.g. cancer cell characterization)
- Information for families weighing their risks for familial genetic diseases
- People with high risk for preventable illness could improve lifestyle or environment
- Used in newborn screening
- Forensic/identity testing

Cons of Genetic Testing

- Costs can range from hundreds to thousands of dollars and insurances rarely cover them
- Commercialized gene tests for adult-onset disorders (Alzheimer's disease and cancers)
- Companies are targeting healthy people
- Results give only a probability of developing the illness
- Issue of Regulation.

Gene therapy

- Somatic gene therapy (treatment of certain genetic diseases and types of cancer by manipulation of certain genes in body cells outside the germ line) falls into the wide field of medical therapy
- It has little impact on public health policy.

Potential Impact of Molecular Genetics on Medicine and Public Health

- Prenatal screening / Diagnostic testing
- Gene therapy
- Define susceptibility to common disease
- Drug discovery / Predicting drug response
- Explain health disparities

Potential Areas of Concern in the Application of Genomics

- Stigmatization of individuals and populations
- Intense commercialization
- Limited applicability in poor countries
- Promotes genetic determinism
- Poses technology as a solution to social problems

Preventive & Social Measures

- Health Promotional Measure
 - Eugenics
 - Euthenics
 - Genetic Counseling
- Specific protection
 - Ionizing radiation
- Early diagnosis & treatment

THANKS