Screening Concepts
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Introduction

• Tenet of public health: primary prevention of disease, the best approach.

• Next best strategy when all cases cannot be prevented: early detection of disease (asymptomatic, apparently healthy individuals).

Introduction (cont).

• Recognized importance of screening programs:
  • secondary prevention of morbidity and mortality.

• Effort to control diseases by early detection:
  • basic change in nature of medical practice from
  • focus upon a small number of ill persons to
  • targeting large numbers of asymptomatic persons.
Session Objectives

- Distinguish screening from diagnosis
- Understand main criteria for screening
- Efficacy and Effectiveness
- Sensitivity, specificity, positive predictive value, and negative predictive value
- The effect of prevalence on other measures

Epidemiologic point of view

- Epidemiology:
  - study of the distribution and determinants of diseases
  - Regarding determinants, ultimate goal:
  - prevent the development of diseases
  - Once the disease is present:
    - Possible to improve the outcome of an illness?

Epidemiology (cont.)

- YES!
  - Reducing the number of cases
  - Reducing the severity of the disease
  - As a consequence, reducing the recurrence
  - Goal with fatal diseases is reducing mortality

- HOW?
  - Screening for early detection of diseases
Screening Definition

- Application of a test (exam)
- People asymptomatic
- Classifying them respect to their likelihood of having a particular disease
- Persons with suspicious findings are referred for follow-up (diagnostic tests and treatment)
- Screening= PH interventions among populations (tool)
- Diagnosis= Clinical intervention applied to individual

Assumptions behind a screening program

- Implicit assumption:
  - early detection, before symptoms, lead to more favorable prognosis
  - Treatment begins before disease becomes clinically manifest more effective than later.
- Other conditions to be considered:
  - Risks
  - Costs

General discussion
Screening for disease control

Primary requirements for screening:

1) Early detection of screened disease: more favorable prognosis due to early treatment
2) Disease should be serious (cost effectiveness, ethics, prognosis)
3) Prevalence of pre-clinical disease relatively high among those screened (sub-population at high risk, such as Tay-Sachs in individuals of Ashkenazi Jewish heritage)
General discussion
Screening for disease control

“Prices” of screening:

1) Financial – very costly if screening is on entire population or if screening method is expensive;
2) Anxiety – individuals may be screened more often if at high risk, not meeting screening criteria for more complete workup;
3) Creation of “lead time” morbidity

General discussion

• Types of screening
  • Mass screening. Large population (PKU, visual)
  • Selective screening. High risk groups (TB prison)
  • Multiphasic screening. Multiple tests (Premilitary, premarital)
  • Case finding. Clinical setting. (Opportunistic: Pap, ECG, Weight, DM, BP. Optometrist: glaucoma )

General discussion (cont).

• Type diseases more suitable for screening

• Factors to consider in the evaluation:
  • Validity of the test itself
  • Feasibility of the program
  • Whether its implementation achieves a reduction in morbidity and mortality from disease
Diseases

Serious disease:
- Ethics: consequences of failing to dx & treat early sufficiently grave to warrant risks & discomforts of test
  - Life threatening diseases: breast cancer
  - Serious & irreversible consequences if not treated early: congenital hypothyroidism & phenylketonuria
- Cost effectiveness:
  - expenditure of resources must be justifiable: eliminating or ameliorating adverse health consequences

Diseases (cont).

Treatment:
- Given before symptoms, more beneficial in reducing morbidity and mortality than given after
  - Good prognosis: nonmelanotic skin cancer, uterine cervix cancer.
  - Bad prognosis: lung cancer
- The PREVALENCE of preclinical disease should be high among the population screened (hypertension)

Diseases (cont).

The PREVALENCE of preclinical disease should be high among the population screened (hypertension)

PREVALENCE proportion of individuals in a population with disease at a specific instant; provides an estimate of the probability (risk) that an individual will be ill at a point in time.

To increase prevalence of cases the program should be applied to high risk populations:
- Bladder Ca in occupational exposure
- Breast Ca with Family History
Diseases (cont).

• Hypertension: disease recommended for screening:
  • Serious disease (high morbidity & mortality)
  • Early treatment reduces risk of subsequent morbidity and mortality (all vascular diseases and stroke).
  • The prevalence in US adults population is 20-25% of high diastolic.

Diseases (cont).

• Not all criterion should be necessary.
  • Example: phenylketonuria:
    • Rare disease (1 out of 15,000 births)
    • Very serious consequences if left untreated
    • Test is available, simple, accurate and inexpensive.

Diseases (cont).

• Cancer of the uterine cervix
• Breast cancer
• Colon cancer
• Prostate cancer (?)
• Neonatal hypothyroidism
• Obesity
• Diabetes mellitus
• Hypercholesterolemia
• Infectious: HIV, Syphilis, TB, Gonorrhea, others (?)...
Summary of prerequisites for a successful screening program

- Condition should be an important health problem
- Should be an accepted treatment for the disease
- Facilities for dx & treatment should be available
- NHD: should be a detectable preclinical phase

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<th>A</th>
<th>B</th>
<th>C</th>
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<tbody>
<tr>
<td>Biologic onset</td>
<td>Disease detectable by screening</td>
<td>Symptoms develop</td>
<td>Death</td>
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Natural History of Disease (ex: cancer)

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<th>Age of Individual</th>
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<td>20</td>
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Birth Exposure | Neoplasia | Cells exfoliate | Screened | Symptom diagnosis | Death |

5 years additional "duration" of disease

Total Pre-Clinical Phase (TPCP)

TPCP: Begins at the true initiation of disease pathology: ends when the disease is clinically manifested (25 years in this example)
Natural History of Disease

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<th>Age of Individual</th>
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<td>Screened Diagnosis</td>
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<td>Symptom Diagnosis</td>
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<td>Detectable Pre-Clinical Phase (DPCP)</td>
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<td>DPCP: Begins when screening test is able to detect disease; ends when disease is clinically manifested (10 years)</td>
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Summary (cont).

- Suitable test or examination (sensitivity & specificity)
- Test acceptable and entail minimum risk (easy to administer/minimal risk)
- Cost: economically balanced
  - relation to possible expenditure on medical care
- Case-finding should be a continuing process
- The test should be:
  - valid,
  - reliable & reproducible

Definition of terms related to test

- **Validity.** Ability to do what it is supposed to do
  - requires a Gold Standard (definite dx test).

- **Reliability.** Consistency of results
  - Repeat test on the same person under same circumstances.

- **Reproducibility.** Four sources of variability:
  - Biological variation
  - Variation of the test method (instrument)
  - Intra-observer variability
  - Inter-observer variability
Evaluation of a screening program.

- Feasibility
  - Acceptability
  - Cost effectiveness
- Subsequent diagnosis and treatment of those who test positive (mammography).
- Yield of cases (number of cases detected), PPV

- Efficacy of the test
- Effectiveness of the test

Efficacy of a screening test

- Efficacy Definition
  - ability to produce accurate results under ideal conditions, (Randomized clinical trials).
- Intrinsic properties:
  - Accuracy (validity),
    - Accuracy indices:
      - (Sensitivity, Specificity, PPV, and NPV).
  - Reliability (reproducibility)
    - Reliability
      - ability to achieve the same results when repeated.

Effectiveness of a Screening Test

- Effectiveness Definition
  - How well the screening test performs under actual conditions.
    (Observational studies)
  
- NHD must provide adequate lead time* to lead to an improved outcome (reducing morbidity and mortality) after early diagnosis.
  
* Amount of time diagnosis has advanced as result of screening.

- Medical support must be available to actually improve the outcome.
Effectiveness of screening

Evaluating a screening program:

- Overall shift in severity of disease at the time of diagnosis:
  - disease will be detected earlier, more people in early manifestations of disease

- Compare cause-specific mortality:
  - those disease picked up by screening versus
  - those with a diagnosis related to symptoms