The Principles of Screening

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Challenges in Initiating and Conducting Long-Term Health Monitoring of Population Following Nuclear and Radiological Emergencies in the United States
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Definitions

• Primary prevention
• Secondary prevention
• Tertiary prevention
Criteria for Evaluating Screening Tests

- Burden of suffering
- Accuracy and reliability
- Effectiveness of early detection
- Harms
- Balance of benefits and harms
Burden of Suffering

- Frequency: incidence, prevalence
- Severity: morbidity, mortality
- Clinical significance
Criteria for Evaluating Screening Tests

• Burden of suffering
• **Accuracy and reliability**
• Effectiveness of early detection
• Harms
• Balance of benefits and harms
Accuracy and Reliability

- Accuracy
  - Sensitivity (proportion with disease who test positive)
  - Specificity (proportion without disease who test negative)
  - Positive predictive value (proportion who test positive who have the disease)

- Reliability
## Positive Predictive Value and Prevalence

<table>
<thead>
<tr>
<th>Ultrasound</th>
<th>Cancer</th>
<th>No Cancer</th>
<th>Total</th>
<th>PPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive</td>
<td>7000</td>
<td>1860</td>
<td>8860</td>
<td>79%</td>
</tr>
<tr>
<td>Negative</td>
<td>0</td>
<td>91,140</td>
<td>91,140</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>7000</td>
<td>93,000</td>
<td>100,000</td>
<td></td>
</tr>
</tbody>
</table>

Prevalence = 7%

Sensitivity=100%, Specificity=98%
## Positive Predictive Value and Prevalence

<table>
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<tr>
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<th>Total</th>
<th>PPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive</td>
<td>70</td>
<td>1999</td>
<td>2069</td>
<td>3%</td>
</tr>
<tr>
<td>Negative</td>
<td>0</td>
<td>97,931</td>
<td>97,931</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>70</td>
<td>99,930</td>
<td>100,000</td>
<td></td>
</tr>
</tbody>
</table>

Prevalence = 0.07%  
Sensitivity = 100%, Specificity = 98%
Criteria for Evaluating Screening Tests

- Burden of suffering
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- Effectiveness of early detection
- Harms
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Rationale for Early Detection

Early treatment

Asymptomatic | Symptoms | Death

Screening
Stage Shift

- Asymptomatic
- Symptoms
- Death
- Screening
- Early treatment
- Localized
- Regional extension
- Disseminated
Confirming Effectiveness

- Randomized controlled trials
- Well-designed observational studies
- Relative vs. absolute benefit
- Number-needed-to-screen
- Optimal interval
- When to stop
- Selective vs universal screening
Relative versus Absolute Benefit

Example:
“drug X reduces incidence of CRF by 20%”

If baseline risk of CRF is 1:10,000 (0.010%),
drug X decreases incidence to 1:12,000
(0.008%) =

Absolute reduction of 0.002%
NNT = \frac{100}{0.002} = 50,000
Criteria for Evaluating Screening Tests

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- Balance of benefits and harms
Harms of Screening

- Test procedure
- Anxiety and labeling effects
- False-positive results
- Harms of treatment
Potential Harms

- 70 with cancer
  - Treatment complications
  - Clinically insignificant
  - Net benefit

- 1999 false positives
  - FNA Biopsy

Net benefit
Criteria for Evaluating Screening Tests

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Logic for Screening

Asymptomatic Men

Screen
PSA, DRE

Early Prostate Cancer

Treat:
radiation, prostatectomy

Reduced prostate cancer morbidity, mortality

Adverse effects of screening:
false +, false -, inconvenience, labeling

Adverse effects of Rx:
Impotence, incontinence, death, overtreatment
Balance of Benefits and Harms

- Objective component
- Subjective component

- Resources
- Feasibility
- Politics and public expectations
- Ethical and legal factors
Who is on the Guideline Panel?

• Topic experts and specialists vs. generalists and experts in analytic science
  – Conflicts of interest
    • Intellectual
    • Financial
  – Referral bias