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Screening

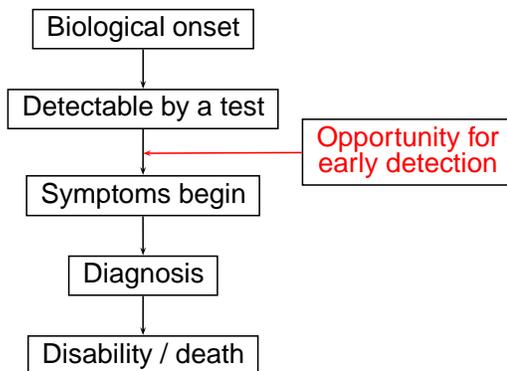
Seattle Epidemiology and
Biostatistics Summer Session
June, 2004

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Introduction

3

Time course of many diseases



Examples of diseases to which model applies

- Cervical cancer
- Hypertension
- Hearing loss in older adults
- Glaucoma
- Congenital hypothyroidism
- Many others

Suitability for screening—1

- Condition a frequent or serious public health problem
- Favorable opportunity for screening between detectability and symptom onset
 - Long pre-clinical phase, or
 - Already receiving care at right time
- Effective treatment. . .
 - Exists
 - Is available to target population
 - Improves screenee outcomes or prevents spread to others

Suitability for screening—2

- Treatment clearly more effective when given before onset of symptoms than afterward
- Suitable screening test available
 - Reliable
 - Sensitive and specific
 - Reasonably inexpensive and safe
 - Acceptable to population screened

Screening test performance

Iron deficiency anemia in children

- Prevalence about 2% among children age <2 years in national surveys
- Cognitive impairments may not be reversible unless treated early
- *Reticulocyte hemoglobin content test (CHr)* about 83% sensitive and 75% specific*
- If a screened child tests positive on CHr, how likely is it that he/she will turn out to have iron deficiency anemia?
- **Only 6.3% (!)**

*(Source: JAMA 1999; 281:2225–30)

Projected results of screening 5,000 children

CHr	True iron deficiency anemia		
	Present	Absent	
+	83	1,225	1,308
-	17	3,675	3,692
Total	100	4,900	5,000

- Prevalence = 2%
- Sensitivity = 83%
- Specificity = 75%
- Subtract to get other 2 cells
- Add to get row totals

Predictive value of positive CHr = $83/1,308 = .063$

Predictive value of negative CHr = $3,675/3,692 = .9954$

Predictive value of a test

Test result	True disease status	
	Positive	Negative
Positive	a	b
Negative	c	d

$$PV_+ = \frac{a}{a+b}$$

$$PV_- = \frac{d}{c+d}$$

Note that resulting estimates are meaningful only if column totals reflect actual disease prevalence.

Predictive value depends on prevalence

Assuming sensitivity = 83%, specificity = 75%:

Prevalence	PV ₊	PV ₋
0.5%	.016	.9989
1.0%	.032	.9977
2.0%	.063	.9954
5.0%	.149	.9882
10.0%	.269	.9754

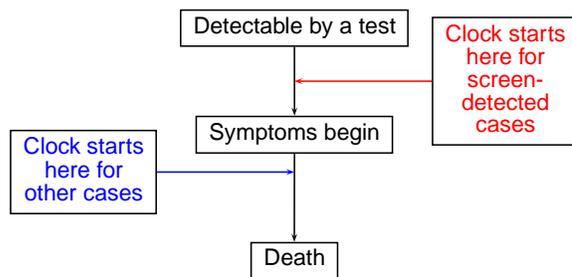
Implications

- Positive screening-test results must be interpreted cautiously
- False positives can...
 - Comprise large proportion of all positive screening-test results
 - Cause needless worry, fear
 - Necessitate costly, uncomfortable, or risky confirmatory tests that would have been avoided without screening
- Yield is higher, and burden of false positives lower, when screening aimed at target populations with high prevalence

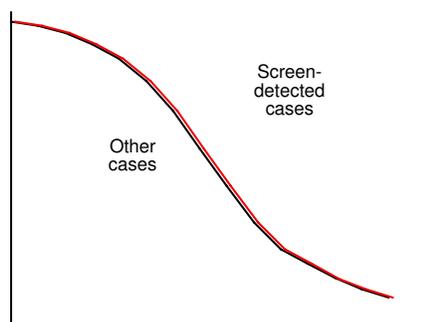
Pitfalls in evaluation of screening

Lead time bias

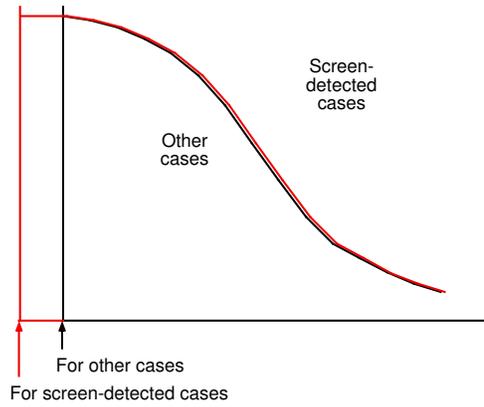
Suppose survival time after diagnosis is compared between screen-detected vs. other cases:



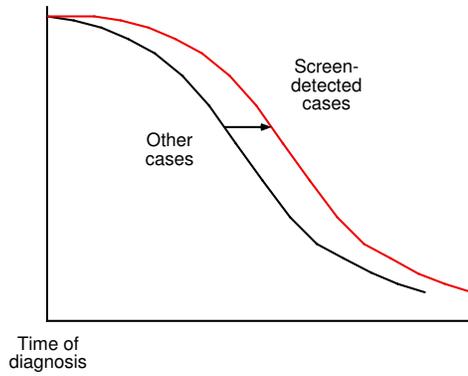
Survival of screen-detected vs. other cases—1



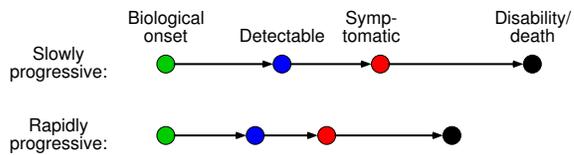
Survival of screen-detected vs. other cases—2



Survival of screen-detected vs. other cases—3



Length-biased sampling



- Pace of disease progression varies among cases
- Cases detected by screening skewed toward more slowly progressive disease

Epidemiologic Perspectives



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- Ed Boyko, MD, MPH, Seattle ERIC Director, interviews Polly Newcomb, PhD, Member and Program Head, Cancer Prevention Program, Fred Hutchinson Cancer Research Center, about her study on Long-term Efficacy of Sigmoidoscopy in the Reduction of Colorectal Cancer

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Introduction to Epidemiologic Methods — Summer, 2004
Discussion Questions: Screening

Lichtenstein and colleagues studied alternative methods for detecting hearing impairment in the elderly. One method determined whether a subject could hear a tone emitted by a hand-held audioscope at a standardized frequency and loudness level. Another method asked subjects to complete a 10-item questionnaire, the Hearing Handicap Inventory for the Elderly—Screening version (HHIE-S). Each of these tests was evaluated against a gold standard, pure-tone audiometry administered at a hearing evaluation center.

In the elderly population studied, 30% of patients proved to have impaired hearing by pure-tone audiometry. The audioscope test had sensitivity = .94 and specificity = .72, while the HHIE-S test (at a cutoff score of 24) had sensitivity = .41 and specificity = .92.

1. Suppose that you are a physician in that setting, evaluating a typical elderly patient for hearing impairment. You have just obtained a positive result with the audioscope test. How likely is it that your patient actually has hearing impairment?
2. Suppose that, in the same patient, you had administered the HHIE-S test first instead of the audioscope test, and obtained a positive HHIE-S result. How likely is it under this scenario that your patient has hearing impairment?