10.1 - Prevention

Epidemiologists, medical and public health professionals use the terms 'primary prevention', 'secondary prevention' and even 'tertiary prevention'. What is the difference between primary and secondary prevention of disease? What is an example of tertiary prevention?

primary prevention - prevents the *onset* of disease, which may be accomplished through the removal of a risk factor. For example, eating more fruits and vegetables may reduce the risk of onset of diabetes, insulin resistance, colon cancer or heart disease. Immunizations against diseases are another example of primary prevention.

Secondary prevention - the detection of disease among *asymptomatic persons*, when treatment of early disease can reduce morbidity or mortality.

Tertiary prevention - the prevention of *health deterioration* once *disease is present.* For instance, once diagnosed with diabetes, managing insulin levels and regularly examining feet is tertiary prevention, relieving or preventing complications of the disease.

Let's try to apply these terms (you'll find that it is not as easy as it is defined)....

Think About It!

Come up with an answer to this question and then click on the icon to the left to reveal the answer.

What level of prevention is:

- Control of blood glucose among diabetics?
- Increasing physical activity?
- Increasing physical activity among diabetics?
- Quitting smoking?
- Eliminating cigarette vending machines from places frequented by adolescents?
- Detecting polymorphisms for a breast-cancer gene such as $BRCA_1$?

Is prevention of disease a worthwhile effort? Danaei, Ding et al. [1](2009) assessed the effects of 12 modifiable risk factors on mortality in the U.S. These authors estimated that tobacco smoking and high blood pressure were responsible for 467,000 and 395,000 deaths respectively, in 2005, accounting for about one in every five or six deaths among U.S. adults. Overweight-obesity and physical inactivity each accounted for 1/10 deaths. If the U.S. population was filled with active nonsmokers with controlled blood pressure who were not overweight, perhaps as many as 4/10 deaths would be averted each year! These substantial numbers support the importance of epidemiological studies applied to the prevention of disease, as opposed to simply identifying causative factors.

If a large proportion of deaths is associated with preventable risk factors, should resources be allocated to eliminating these risk factors? In the face of competing demands and finite

resources, what preventative measures have the greatest impact? Which services should be the focus of clinical practice improvement and national policies and programs? Masciosek et al rank 25 evidence-based clinical primary and secondary preventative services based on their relative value to the U.S. population (as of 2004 information). The measures used for the rankings were clinically preventable burden (CPB) and cost effectiveness (CE). CPB was defined as the disease, injury and premature death that would be prevented if the service were delivered at recommended intervals to a U.S. birth cohort, expressed as quality adjusted life years. CE was defined as the average net cost per QALY gained by offering the preventative service. The Partnership for Prevention lists the rankings and provides supporting evidence on their website: https://www.prevent.org/content/view/43/71/ [2] Clicking on a preventative service in the rankings brings up mortality rates, incidence rates, and risk factor prevalence by sub-population when those data are available.

Think About It!

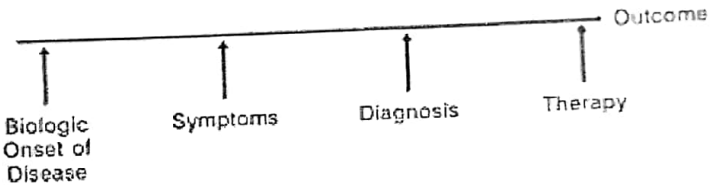
Come up with an answer to this question and then click on the icon to the left to reveal the answer.

Suppose you are health director of the state of Pennsylvania and you have options of implementing free breast cancer screening versus free vaccination of children (let's say MMR - measles, mumps, rubella) - but only enough resources for one project- which will you choose? You might consider the cost of mammography versus the cost of the vaccination. Mammography is much more expensive than MMR vaccination. Vaccination is relatively simple. Vaccine is delivered to clinics, children innoculated. Disease prevented. However, it is also important to look at effectiveness in reducing preventable mortality. How would these rankings help you reach your decision?

10.2 - Early Detection and Screening

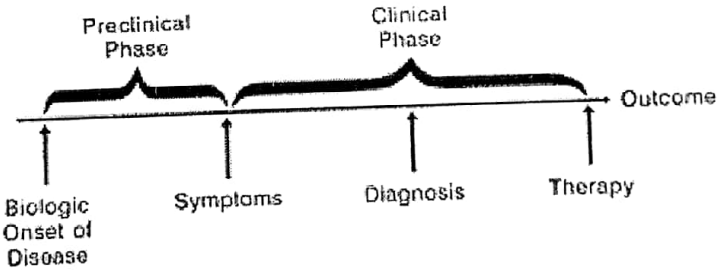
In this course, we are characterizing early detection and screening as secondary prevention. Classic examples include mammography to detect breast cancer, Pap smears to detect cervical cancer, fasting blood glucose to detect diabetes, PSA's to detect prostate cancer, etc.

Let's look at Gordis' map of a natural history of disease, (from: Gordis L. *Epidemiology.* Philadelphia: Saunders and Company, 1996). Biological onset of disease is followed by clinical symptoms, then diagnosis, and therapy until there is an outcome.



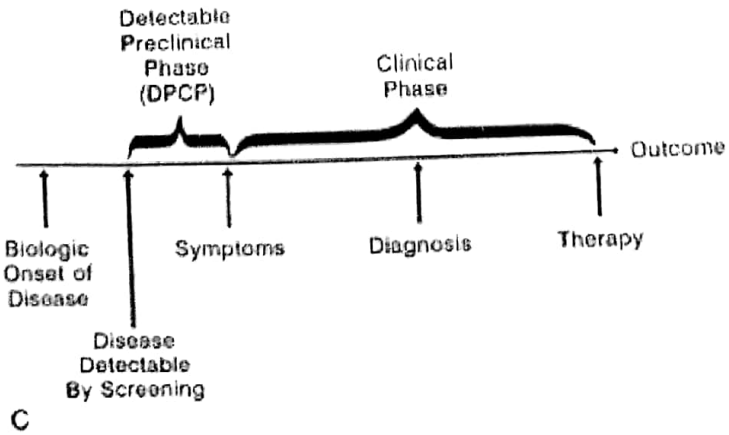
A

We can label phases in this process. From the onset of disease until clinical symptoms occur is the **pre-clinical phase**. The individual has the disease but doesn't know it. The **clinical phase** is the latter part of the process, from the occurrence of clinical symptoms through therapy.



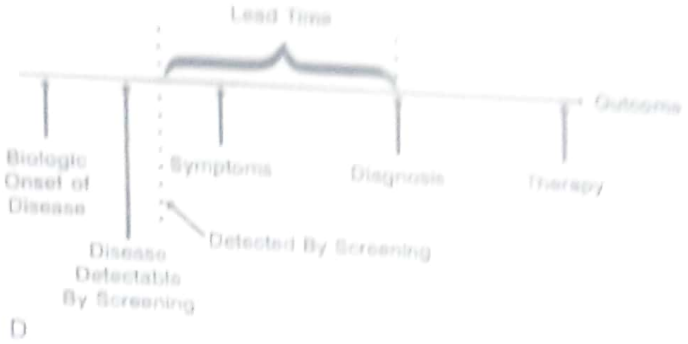
B

Within the preclinical phase, there may be an interval between the onset of the disease and the occurrence of clinical symptoms during which disease can be detected with certain tests. This is called a **detectable pre-clinical phase**. If treatment is more effective when disease is in the preclinical stage, screening for disease during the detectable pre-clinical phase offers an advantage.



C

The gain from screening for disease is the difference between the time a disease would have been diagnosed by clinical symptoms and when it is detected with a screening procedure. This is the **lead time**.



Diagnostic Tests for Asymptomatic Disease or Disease Risk

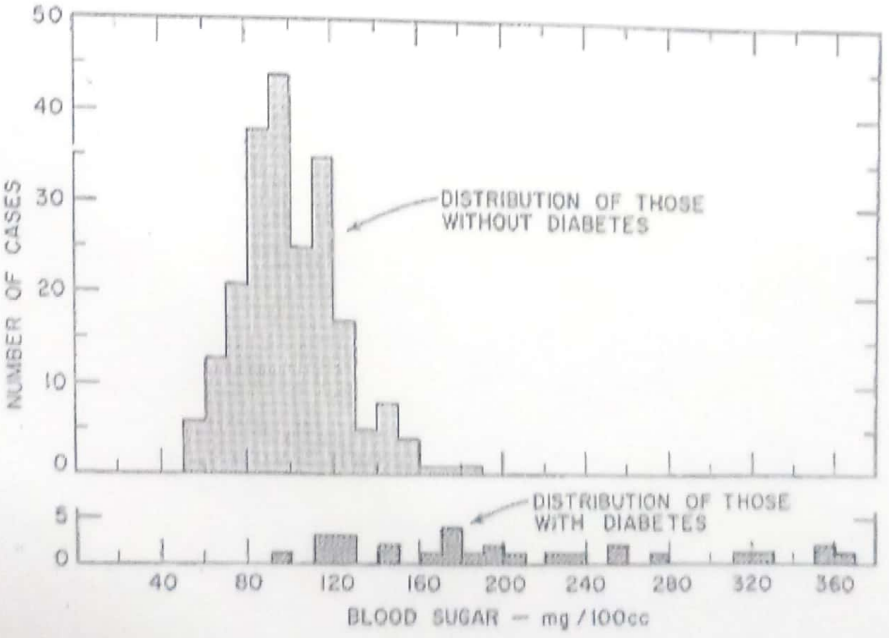
What is the Objective of Screening?

- To improve the quality of life or to reduce the morbidity and mortality for an individual, by applying effective treatment to disease or increased risk **at an early stage, when treatment is more effective** than if it were applied at a later stage.

To meet this objective, we seek to identify diseased or at-risk individuals at an asymptomatic stage. This helps us to separate individuals into populations such as:

- diseased vs non-diseased
- at-risk vs not at-risk

However, screening tests are not 100% accurate at classifying individuals. As a result, the distributions are not completely separated. For example, consider the distributions of blood sugar in diabetics and non-diabetics as depicted below. How would you set the cutpoint for a test of blood sugar to indicate diabetes? If you choose a low value, people with normal blood sugar will be included among the diabetics; if you select a high value, some diabetics will be included with the normals.



Distribution of blood sugar in diabetics and non-diabetics
(From Blumberg M: Evaluating health screening procedures. Operations Res 5: 351-360, 1957.)