Measurement Brings Meaning to Population Health

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Healthcare payments are shifting and the industry is in a rapid state of change. Efficiencies to render patient care as a top priority are crucial. Measuring brings efficiencies and meaning to a patient population.

High-Level Measurements

Population-based statistics such as mortality and morbidity rates have long been the focus of mainstream calculations:

- **Incidence Rate and Prevalence Rate:** Typically used to describe measures of morbidity. These two measures can be used to detail race, gender, age, or other population characteristics.
- **Incidence Rate:** Frequency of disease within a population.
- **Prevalence Rate:** Proportion of persons in a population who have a particular disease at a specific point in time or over a specified period of time.

The side bar below provides the generic method for calculating incidence rate and prevalence rate.

Side bar_Incidence and Prevalence Rates

Taking a Deeper Dive

What about measures such as sensitivity and specificity rates? These are measures of validity when assessing correct measurement or correct labeling.

Let’s take early disease screening for dementia as an example to illustrate this concept.

The probability of having the disease among those who test positive for dementia may be derived through a computation of positive predictive value (PPV) using the formula below:

Side bar_PPV Formula

Due to “error” which may be consequent to the inappropriateness of a test, processing, and the variation or overlap in disease groups, we can expect false positives as well as false negatives in our predictions.

The following sections examine each portion of this equation as we break it down piece by piece.

Sensitivity

The sensitivity refers to the probability that an individual will test positive when they do in fact have the disease. This notion is often referred to as the “true positive.” Within the below equation, the vertical bar (i.e. the symbol “|”) implies the term “given” and thus makes room for the condition of other probabilities. This equation would read, “The sensitivity of the test is equal to the probability of a positive test, given the disease is present”:

Side bar_Sensitivity

Prevalence

The prevalence of a disease in the population is the proportion of the population with that disease. That is, prevalence is equal to the probability of disease:

[Side bar_Prevalence]

Specificity

The specificity of a test is the probability that an individual will test negative, when they do not have the disease. This is often referred to as the "true negative":

[Side bar_Specificity]

Positive Predictive Value

A key question in determining the value of a screening tool and subsequent investment in treatment, relative to the shifting healthcare climate is "What is the probability of having the disease given you test positive?" In other words, what is the Positive Predictive Value (PPV)?

[Side bar_PPV]

Negative Predictive Value

Similarly, the probability of being disease-free given a negative test is known as the Negative Predictive Value (NPV):

[Side bar_NPV]

Example Using the Bayes' Rule

Both the PPV and NPV can be calculated via Bayes' Rule (for a description of the rule click here) using known properties of the test (sensitivity/specificity) and the disease prevalence. Bayes' Rule is grounded on the assumption that our "prior" (i.e., background probability of disease) is correct.

Suppose we want to calculate the Positive Predictive Value of an Alzheimer's disease screening test in order to assist in determining the predicted financial investment required for the treatment of individuals testing positive for the diagnosis. Thanks to Bayes' Rule and "conditional probability" we can write and unpack the PPV formula, as illustrated in the side bar below.

$$PPV = P(D+|T+)$$

$$= \frac{P(T+|D+)P(D+)}{P(T+)} (Bayes'Rule)$$

$$= \frac{P(T+|D+)P(D+)}{P(T+|D+)P(D+) + P(T+|D-)P(D-)}$$

$$= \frac{Sensitivity\ x\ Prevalence}{Sensitivity\ x\ Prevalence + (1 - Specificity)\ x\ (1 - Prevalence)}$$

Depending on the availability of data within our organization, we may apply the following information to our computation.

According to the Alzheimer's Association 2015 report, 1 in 9 adults above the age of 65 have Alzheimer's disease:

Prevalence = 0.11

The Magnetic Resonance Imaging (MRI) test has a reported sensitivity of 90.7 percent and a specificity of 84 percent:

Sensitivity = 0.91

Specificity = 0.84

Inserting these values into our formula we arrive at the following computation:

Side bar_Alzheimers Computation

This means that out of every 100 individuals that test positive for Alzheimer's disease using this screening technique, 41 percent will have the disease.

Transforming our data into meaningful information is linked to the success or failure of healthcare. Whether calculations and measurements are more mainstream or more complex, they are meaningful if they advance population health. Here's to a better tomorrow for our patients and their families.

Notes

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