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MEDICAL DIAGNOSIS AND STATISTICAL ERRORS

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Abstract:

Medical diagnosis involves the process of determining the disease. But there is always a risk of making errors in diagnosis. Judging a sick person well is more to be avoided than judging a well person sick. This informal norm for handling uncertainty is part of the subculture of the medical profession. The assumptions underlying it are examined and it is suggested that physicians guided by the rule, too often place patients in the 'sick role' who ought not to be. There is always a risk of making errors in diagnosis. The implications and repercussions of wrong diagnosis must be understood so that necessary steps and procedures may be adopted to curtail the harm that may occur due to such cases.

In this paper we study and explain two types of errors that can commonly occur in disease diagnosis.

Keywords: Type I error, Type II error, Hypothesis, Critical Region, Level of Significance.

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Introduction: The health of population of a country is very important because it plays a vital role in the progress of the nation.All health policies devised by the government and other health care agencies are dictated by the correct statistics on diseases, its diagnosis, prevention and cure mechanisms prevalent in the current scenario. The field of diagnostics is important because correct diagnosis leads to successful implementation of the prevention and cure mechanisms by health agencies.

In this paper we focus on two types of statistical errors i.e., type I and type II errors that occur in disease diagnosis.

Medical Error: A medical error is a preventable adverse effect of care, whether or not it is evident or harmful to the patient. This might include an inaccurate or incomplete diagnosis or treatment of a disease, injury, syndrome, infection, or other ailment. Globally it is estimated that 142,000 people died in 2013 from adverse effects of medical treatment up from 94,000 in 1990.

The word error in medicine is used as a label for nearly all of the problems harming patients. Medical errors are often described as human errors in healthcare. Whether the label is medical error or human error, one definition used for it in medicine says that it occurs when a health-care provider chooses an inappropriate method of care or improperly executes an appropriate method of care. The definition should be the subject of more debate. For instance, studies of hand hygiene compliance of physicians in an ICU show that compliance varied from 19% to 85%. The deaths that result from infections caught as a result of treatment providers improperly executing an appropriate method of care by not complying with known safety standards for hand hygiene are difficult to regard innocent accidents or mistakes.

Statistical Errors in Diagnosis: In statistical hypothesis testing, a type I error is the incorrect rejection of a true null hypothesis (a "false positive"), while a type II error is the failure to reject a false null hypothesis (a "false negative"). More simply stated, a type I error is detecting an effect that is not present, while a type II error is failing to detect an effect that is present. The terms "type I error" and "type II error" are often used interchangeably with the general notion of false positives and false negatives in binary classification, such as medical testing.

In statistical test theory the notion of statistical error is an integral part of hypothesis testing. The test requires an unambiguous statement of a null hypothesis, which usually corresponds to a default "state of nature", for example "this person is healthy". An alternative hypothesis is the negation of null hypothesis, for example, "this person is not healthy". The result of the test may be negative, relative to null hypothesis (not healthy) or positive (healthy). If the result of the test corresponds with reality, then a correct decision has been made. However, if the result of the test does not correspond with reality, then an error has occurred. Due to the statistical nature of a test, the result is never, except in very rare cases, free of error. Two types of error are distinguished: type I error and type II error.

Type I error

A type I error, also known as an error of the first kind, occurs when the null hypothesis (H_0) is true, but is rejected. It is asserting something that is absent, a false hit. A type I error may be compared with a so-called false positive (a result that indicates that a given condition is present when it actually is not present) in tests where a single condition is tested for.

The type I error rate or significance level is the probability of rejecting the null hypothesis given that it is true. It is denoted by the Greek letter α (alpha) and is also called the alpha level. Often, the significance level is set to 0.05 (5%), implying that it is acceptable to have a 5% probability of incorrectly rejecting the null hypothesis.

Type II error

A type II error, also known as an error of the second kind, occurs when the null hypothesis is false, but erroneously fails to be rejected. It is failing to assert what is present. A type II error may be compared with a so-called false negative in a test checking for a single condition with a definitive result of true or false. A Type II error is committed when we fail to believe a truth.

The rate of the type II error is denoted by the Greek letter β (beta) and related to the power of a test (which equals $1-\beta$).

What we actually call type I or type II error depends directly on the null hypothesis. Negation of the null hypothesis causes type I and type II errors to switch roles.

The goal of the test is to determine if the null hypothesis can be rejected. A statistical test can either reject or fail to reject a null hypothesis, but never prove it true.

Table of error types

Tabularized relations between truth/falseness of the null hypothesis and outcomes of the test:

Table of error types Chart		Null hypothesis (H_0) is	
		Valid/True	Invalid/False
Judgment of Null Hypothesis (H_0)	Reject	Type I error (False Positive)	Correct inference (True Positive)
	Fail to reject	Correct inference (True Negative)	Type II error (False Negative)
Type-1 = True H_0 but reject it (False Positive) Type-2 = False H_0 but accept it (False Negative)			

Impact of Diagnostic Errors in case of HIV/AIDS

- Nearly 37 million people are now living with HIV.
- 2.6 million are under the age of 15.
- In 2014, an estimated 2 million people were newly infected with HIV.
- 220,000 were under the age of 15.
- Every day about 5,600 people contract HIV—more than 230 every hour.
- In 2014, 1.2 million people died from AIDS.
- Since the beginning of the pandemic, nearly 78 million people have contracted HIV and close to 39 million have died of AIDS-related causes.
- As of March 2015, around 15 million people living with HIV (41% of the total) had access to antiretroviral therapy.

Conclusion:

- In such a scenario, accurate diagnosis at early stages of the disease is of extremely vital importance. Hence, high probabilities of Type I or Type II error can be disastrous.
- A patient might take HIV test, promising a 99.9% accuracy rate. This means that 1 in every 1000 tests could give a "false positive" , informing a patient that they have the virus, when they do not.
- Wrong diagnosis can often lead to often dangerous consequences.
- Hence we need to develop diagnostic test procedures that are full proof.
- Wrong health policy making decisions and legal hassles can be avoided if proper attention is given to minimize these errors.
- This will be an encouraging step for ensuring good health to all of us, which is our basic right.

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