Hill's Criteria of Causation

A British statistician named Austin Bradford Hill (1897-1991) presented a set of conditions that should be present before we can claim causality between and exposure and an outcome for example between smoking and lung cancer. Finding an association between an exposure and an outcome even a statistically significant one, does not necessarily mean that the outcome is caused by the exposure. Before judging on causality we have to evaluate such an association in the wider context of current scientific knowledge and explore other possible causes of the relationship. One useful tool to help researchers do this is following Hill's criteria which was developed Austin Hill and elaborated by other researchers. Whenever we find a statistically significant association between an exposure and an outcome, we have to evaluate it in the light of the following criteria before judging on causation.

1. ***Temporal Relationship***

   To be a cause, the exposure should always precede the outcome. If we want to say that smoking causes cancer, then people should have been smokers before cancer has developed. When we judge causality it is essential that we make sure the exposure was present before the outcome has occurred. This may be evident in tangible attributes, but when it comes to social and behavioral characteristics it may be not be so apparent.

2. ***Strength***

   How strong is the association which we have found? We calculate measures of effect using multivariate analysis for the relationship of the exposure and the outcome. The larger the effect, the more likely is causality. For example factor "A" is more likely to be a cause for event "B" if the adjusted odds ratio was 5 than if it was 2.

3. ***Dose-Response Relationship***

   If the amount of the effect increases with increase in the amount of the exposure, this is called a dose-response relationship. For example if we find that risk of slung cancer increases with the number of cigarettes smoked, this indicates a presence of dose-response relationship. If such a relationship exists between factor "A" and event "B", it is strong evidence for causality. However absence of this dose-response relationship does not eliminate probability of causality.

4. ***Consistency***

   Consistency means similar findings have been reported by similar studies by other researchers elsewhere. If factor "A" haven been found to be associated with even "B" in many studies, different places and settings, it is in favor of a causal relationship. But if this relationship has not been found by other studies it makes the association doubtful.

5. ***Plausibility***

   Plausibility refers to meaningfulness of the findings according to current knowledge. Does the association we have found have theoretical basis? Can we

explain and understand the biological and pathological processes which are involved in the association and causation? If we could explain our findings in light of current knowledge, it is more likely that there is a causal relationship.

6. Alternate Explanations

There may be more than one explanation for any event. Before judging on causality of factor "A" to event "B", we have to think of other possible explanations for the association we have found between "A" and "B". Unless you explore other possible causes (other hypotheses) and rule them out, you may not be confident enough to claim causal relationship for the association you have found.

7. Experiment

Is it possible to undertake an experiment, a trail, to test the association? Can we change the course of the event by manipulating the exposure? What happens if we could remove the exposure? This may not be possible in many situations. But if we could do such a trial, it will be a strong evidence of causation.

8. Coherence

Is the association we have found at odds with the current state of scientific knowledge or it is compatible? Coherence means the association does not contradict existing theories in the specific field in related fields of knowledge; it could be explained and evaluated within the context of the current state of science.

9. Analogy

If the association we have found is similar to another association we already know, then causal relationship is more probable. For example we already know that smoking causes lung cancer. If in a new study we find strong association between smoking and another cancer, this would be more acceptable since we already know that cancer pathologies have similarities and that smoking in related to lung cancer.

10. Specificity

Specificity means a specific exposure always causes a specific outcome. For example factor "A" always produces event "B". if such a specificity exists it favors causal relationship. But this not often so in health research since many conditions are multifactorial i.e. one outcome can be caused by several exposures and one exposure can contribute to several diseases. For example lung cancer could be cause by smoking as well as other factors and smoking can contribute to lung cancer as well as other diseases. Therefore this is a weak criteria.

***