Causality; deals with the relationship between cause and effect.

Causal inference

The Scientific conclusions are derived by two methods of reasoning:

- Deduction
- induction

1 Deduction:

- is arguing from the general to the particular; that is, a general case is established, from which all dependent events are argued to be true.

- example **'all dogs are mammals'**, thus **any dog will be a mammal**.

2 Induction:

- is arguing from the particular to the general.

- a dog may be vaccinated against distemper virus, the conclusion is drawn that the vaccine prevents distemper in all dogs.

Methods of acceptance of causal hypotheses:

1 Tenacity

- Habit makes it easy to continue to believe a proposition and to offer a **closed mind**.

- Example, some people continued to believe that smoking was beneficial, even that it induced lung cancer.

2 Authority

Appeal is made to a highly respected source to substantiate views.

- Eg. the **religious beliefs**.

3 Intuition

- Some propositions may be considered to be self-evident, without evidence.

- Many veterinarians judged speed of slaughter of animals on infected premises to be crucial in the control of foot-and-mouth disease before firm evidence in support of this proposition was presented.

   Note: Tenacity, authority and intuition may all contribute, to varying degrees, to an individual's belief in the veracity of a hypothesis.

4 Scientific inquiry

- Clarity, order and consistency in fixing beliefs, independent of the idiosyncrasies of a few individuals, are required.

- This is involves making objective observations that can be repeated by many investigators.
- It differs radically from tenacity, authority and intuition, which generally exclude the possibility of errors and have no provision for correcting them.

Koch's postulates; by Robert Koch in the late 19th century, to determine the cause of infectious disease

- **Koch's** postulates, are based on inductive reasoning, state that an organism is causal if:
  1) it is present in all cases of the disease;
  2) it does not occur in another disease as a fortuitous and non-pathogenic parasite;
  3) it is isolated in pure culture from an animal, is repeatedly passaged, and induces the same disease in other animals.
- A more cosmopolitan theory of cause was needed.

Evans' rules

- Alfred Evans (I976) has produced a set of rules that are consistent with modern concepts of causality:

  Important characteristic of Evans' rules:

- establishing causality for both infectious and non-infectious diseases.
- This involves comparing groups of animals, rather than investigating associations in the individual.

Causal models

- The associations and interactions between direct and indirect causes can be viewed in two ways.

1 **Sufficient Cause**

- precedes the disease
- if the cause is present, the disease always occurs
- **Example,** distemper virus is referred to as the cause of distemper, although the sufficient cause actually involves exposure to the virus, lack of immunity and, possibly, other components.

2 **Necessary Cause**

- precedes the disease
- if the cause is absent, the disease cannot occur
- **example**, lead is a necessary cause of lead poisoning, and *P. multocida* is a necessary cause of pneumonic pasteurellosis.
- **Multifactorial syndromes**

- Involve of several causes
- such as pneumonia can have many sufficient causes, although no single component cause is necessary.

Formulating a causal hypothesis

Time

- Associations with year, season, month, day, or even hour in the case of food poisoning investigations, should be considered.
- Such details may provide information on climatic influences, incubation periods and sources of infection.
- For example, an outbreak of salmonellosis in a group of cattle may be associated with the introduction of infected cattle feed.

Place

- The geographical distribution of a disease may indicate an association with local geological, management or ecological factors, for example nutritionally deficient soil or arthropod transmitters of infection.
- Epidemiological maps are a valuable aid to identifying geographical associations.
- For example, mapping of the location of cattle fatalities in South Africa, linked to meteorological data, revealed that the fatalities were due to ingestion of grass contaminated with copper from a nearby copper mine.

Population

- The type of animal that is affected often is of considerable importance. Hereford cattle are more susceptible to squamous cell carcinoma of the eye than other breeds, suggesting that the cause may be partly genetic.
- In many parts of the world, meat workers are affected more often by Q Fever than are other people, implying a source of infection in meat-processing plants.

Methods of deriving a hypothesis

There are four major methods of arriving at a hypothesis:

1. method of difference;
2. method of agreement;
3. method of concomitant variation;
4. method of analogy.