



Four Commonly Misused Research Terminologies in Neurosurgery Research

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Introduction

An accurate answer to a research question can only be obtained from a properly designed and reported study. A proper understanding and the use of research terminology is the fundamental foundation of any clinical study. We often get little exposure to research methods within the medical field, and it is often intimidating when faced with our first research project. Specific terminology such as retrospective/prospective is often misused by even well-seasoned epidemiologists (1). Quite often in papers, authors use these terms synonymously with case-control and cohort studies, respectively, on the premise that the former looks backward from disease to a particular cause while the latter looks forward from exposure to an outcome (2). Other literature recommends using this temporal classification to refer simply to the relationship between the initiation of the study by the investigator and the occurrence of the disease or outcome (2). This holds true for case-control studies and helps to distinguish between retrospective and prospective cohort studies.

To eliminate this confusion and ensure consistency in the correct reporting of research, we have in this mini-review attempted to provide the updated definitions of four commonly ill-defined terminologies: prospective, retrospective, prolective, and retrolective. The use of correct research terminology is essential for the appropriate sorting and indexing of evidence, enhancing research quality and the proper application of scientific knowledge to patient care. The definition of the terminologies; -Exposure and Outcome are an essential pre-requisite for the understanding of the aforementioned four terminologies.

Defining the Exposure and the Outcome

Almost all clinical trials are non-aetiological studies because they assess the treatment outcomes. However, other risk assessment studies (cohort and case-control studies) can study disease etiology due to their observational nature. Therefore, cohort studies and case-control studies can be further categorized into etiological and non-etiological studies. The meaning of exposure and outcome differs between aetiological and non-aetiological studies (Table 1).

Table 1 The definition of exposure and outcome according to the type of the study

| | Definition | What exposure means? | What outcome means? |
|---|---|---|--|
| Aetiological studies | Studies that focus on the etiology of the disease. Studies where the investigators study the factors related to the occurrence of the disease. | Risk factors of the disease occurrence. Factors that increase or decrease the possibility of developing a disease. | Disease occurrence (Yes or No) |
| Non-aetiological studies or (Clinical effectiveness studies) | Studies that focus on the treatments of the disease. Studies where the investigators study the outcomes of different treatment options. | Common exposures in neurosurgery are the different surgical techniques. Exposure may represent a “new surgical technique” (e.g., endoscopic pituitary surgery), while non-exposure/control may be the “gold standard for that procedure” (e.g., microscopic pituitary surgery). | Clinical scores and patient outcomes as recovery, survival, mortality, AEs, .. etc |

An exposure may represent an intervention to which individuals are subjected (e.g., surgery), a behavior (e.g., smoking), or an individual attribute (e.g., age, sex, and race) (3).

Exposure can be dichotomized as present or absent or may be presented as graded levels of exposure, such as blood pressures (e.g., the higher the blood pressure, the higher the risk for stroke).

The outcome refers to the disease state, event (.e.g. complication, recurrence), behavior, or condition associated with health under investigation(3). Common outcomes in neurosurgery are the extent of tumor resection, complications, or recurrences.

In cohort studies and trials, participants are selected based on exposure status, while in case series and case-control studies, they are sampled based on the disease or outcome status.

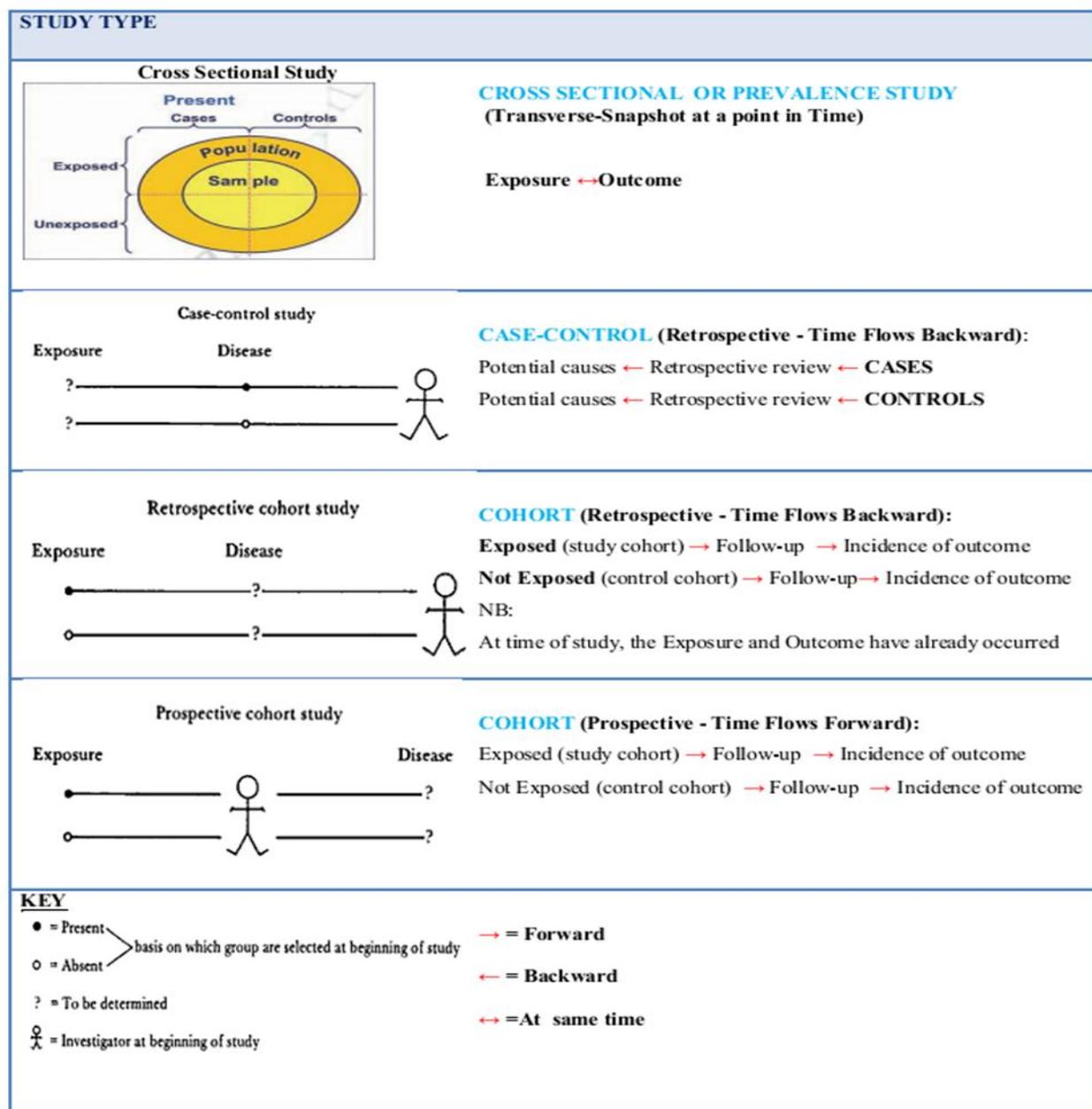
Prospective versus Retrospective

When a population group is studied, the terms retrospective and perspective can be applied for two different research tasks and are thus defined by two parameters: the study timing and directionality.

Timing

Timing refers to the temporal relationship between the initiation of the study by the investigator and the occurrence of the disease or outcome, as illustrated for cohort and case-control studies below (2).

Depending on whether the outcome of interest has occurred at the time the investigator initiates the study, cohort studies can be classified as prospective or retrospective. Cohort studies in which the exposure and outcome have already occurred at the time of study are termed retrospective, non-concurrent, or historical cohort studies, while those in which the outcome has yet to occur are called prospective or concurrent cohort studies (3). (Figure 1).



(Modified from Hennekens et al. 1987.) (5)

Figure 1: Timing of case-control, prospective cohort and retrospective cohort studies in relation to exposure and outcome.

For case-control studies, the outcome and exposure have already occurred at the time of the study. Thus, they are described as retrospective studies. Most cases included in a case-control study are prevalent cases (i.e., include both new and old disease events). However, in the rare condition of the nested case-control study, investigators study the incident cases only (i.e., new disease events that occurred within a large prospective cohort study). These incident case-control studies are special because their temporality is prospective (2).

Directionality

Directionality is the investigation's direction vis-à-vis exposure and outcome (Figure 1).

The cohort study design looks forward from exposure (intervention) to the outcome (disease) and is prospective. Cohort studies are equally known as longitudinal studies; this term emphasizes that patients are followed over time, or incidence studies, drawing attention to the basic measure of new disease events over time. Irrespective of the data collection method, a cohort study always includes a comparison between the exposed vs. the non-exposed group.

The case-control design looks backward from the outcome (disease) to the putative exposure (intervention). Thus, case-control studies are said to be retrospective (2). Irrespective of the data collection method, a case-control study always includes a comparison between the cases (the group with the outcome of interest) vs. the control group (the group without the outcome of interest).

Prolective versus Retrolective

Data collection for a study can be prolective or retrolective. Prolective describes the use of data collected in the future from the start of the study, and retrolective describes the use of data collected in the past from the start of the study. In prolective studies, data collection occurs after study planning and is sourced directly from the origin (e.g., questioning study subjects). On the contrary, retrolective studies use data from secondary sources, i.e., existing before the research is conducted, and usually use data recorded for purposes other than the study. These secondary sources include databases, admission and operative records, patient files (i.e., retrospective chart review). Of note, studies can combine both prolective and retrolective data collection. These study types are called ambilective studies, and as suggested, they use data from primary and secondary sources (4).

Cohort studies have an exposure-to-outcome directionality and are often prolective albeit can also be retrolective. Retrolective cohorts are also called historical cohort studies. Case-control studies, on the other hand, are generally retrolective but can also be prolective (4).

In conclusion, there is a clear distinction between the terms prospective versus retrospective and prolective versus retrolective.

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