Types of Research Designs

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THIS IS THE FIRST IN A SERIES OF columns that will address issues about research. For many of you, the information will be a concise review of familiar topics. For others, the series may serve as an introduction to some research concepts. In either case, the material will be an overview of the topics. In-depth descriptions are beyond the scope of this column. References to help you find more comprehensive discussions of the topics will be provided, however.

Most nurses are familiar with a type of research called *clinical trials.* Typically, a clinical trial is an experimental design in which each subject is randomly assigned to either a control group or a treatment group. The true experimental design is considered to be the most stringent and desirable research design. Use of such a design is not always possible or practical, however, and other designs can provide valuable scientific knowledge as well. This column describes research designs, discusses criteria for evaluating the use of each one, and discusses the interpretation and use of the findings.

EXPERIMENTAL DESIGNS

Sullivan-Bolyai and Grey contend that true experiments have three properties: randomization, control, and manipulation. Experimental designs are generally used to test cause-and-effect relationships and help to eliminate alternative possible explanations for research findings.[1] The three properties of true experiments can be defined as follows.

Randomization is the nature by which subjects are assigned to groups. By definition, for group assignments to be random, they must have no pattern, purpose, organization, or structure. The procedure of random assignment to groups assumes that study variables will be equally distributed between the groups.[1] This property is difficult to maintain in most clinical populations, however. Premature births cannot be randomly assigned, for example. Alternative designs may therefore need to be considered for comparing infants born prematurely to those born at full term. The same is true for studies of children with other complications seen in the newborn period, such as intraventricular hemorrhage and seizure disorders, that cannot be randomly assigned.

Control is the second property of an experimental design. Control involves the manipulation of causal or independent variables.[1] The researcher tries to "systematically rule out variables that are possible 'causes' of the effects under study other than the variables hypothesized to be the 'causes'" (p. 5).[2] Without control, observations sometimes lead to erroneous conclusions. If an event that occurs fits with a researcher's bias about the relationship between two variables, the researcher may conclude that one caused the other, even without controls for other possible causes of the event. For example, when an infant is diagnosed with cerebral palsy (CP), an event at delivery may be implicated as "causing CP." Such an explanation seems plausible and confirms our bias. Alternative causes, such as prenatal events or conditions that may have preceded or maybe even precipitated the delivery events have not been "ruled out," however. A great deal more data are needed for conclusions to be based on scientific evidence rather than on "gut feelings" or personal biases. As researchers and consumers of research, we cannot accept that a hypothesis is supported without substantial evidence obtained through careful consideration of all other possible explanations and without confirmation through the data that none of the alternative explanations is plausible.

The last property of an experimental design is *manipulation*. Manipulation is characterized by a researcher's intervention with at least one group of subjects.[1] This manipulation should be based on some theory that the specific intervention might cause the relationship between the two variables. When the mechanisms of a disorder such as apnea of prematurity are clearly understood, for example, and when the properties of medications such as caffeine have been identified, a hypothesis based on empirical evidence might be that caffeine can be used successfully to treat the disorder. Experimental studies must then be done to determine if the hypothesis is correct.

Why doesn't everyone use experimental designs? Although such designs are most appropriate for identifying cause-and-effect relationships, they are not always possible.[1] In many cases, in fact, the use of an experimental design is neither possible nor appropriate. Because of the nature of the phenomena studied in nursing, and because the use of human subjects requires ethical consideration, not all variables can be manipulated, controlled, and/or randomly assigned. Inducing a cardiac arrest in an infant in order to test a new resuscitation intervention would not be possible, nor ethical, for example.

Furthermore, to conduct a true experiment, the researcher must know all of the variables that might influence the phenomenon of interest.[1] Yet as a research discipline, nursing is in a relatively early stage. Descriptive data may therefore be needed to develop theoretical models that can later be tested through experimental designs. For these and other reasons, experimental designs are not the only methods used to collect empirical evidence.

QUASI-EXPERIMENTAL DESIGNS

Quasi-experimental designs, or *compromise designs*, are used when one or more of the properties (randomization,

control, or manipulation) of an experimental design cannot be provided.[2] Use of a quasi-experimental design may limit application of the findings but does not decrease the contribution of empirical evidence to scientific knowledge in the field of study.[1] Knowledge obtained through a variety of means makes some contribution to science. The more stringent a researcher is in the design of a study, however, the more confidence consumers of the research have in using the findings to guide practice and future research. The researcher must therefore plan the quasi experiment carefully to control as many threats to validity as possible.

The most commonly used quasi-experimental design involves a control group and an experimental group without guaranteed group equivalence. In general, this design is known as the *nonequivalent control group design*.[2] Cook and Campbell described eight variations of this design, including cohort designs, repeated treatment designs, and posttest only designs. (See Cook and Campbell for an in-depth description of the eight variations.)[3]

Another commonly used quasi-experimental design is the time series design.[1,2] In this design, a group of subjects is studied at multiple periods over time. A time series design may involve one group or more than one group.[4] Because testing is done at multiple data-collection points with the same subjects, threats to internal validity (such as history) can be minimized.[1]

Time series designs are commonly used in child development to examine issues related to what occurs over time. Researchers must control other variables, such as age or growth, that may influence developmental changes.[2] Children change over time even without treatment. Interpretation and application of the findings depend therefore on the control of other variables that might explain the change in the dependent variable.

If quasi-experimental designs are *almost* (or *quasi*) experiments, why do researchers use them so commonly? Quasi-experimental designs are adaptable to practice settings, practical, feasible, and can be generalized to larger populations.[1] Some phenomena (especially those related to human subjects, such as health and behavioral variables) cannot be studied using experimental designs. To enhance scientific knowledge in some subject areas, therefore, quasi experiments are necessary. Just as when using experimental designs, experimenters must rule out alternative explanations whenever possible when using quasi experiments. A study can be designed to test for plausible alternative explanations prospectively if data upon which to base such a design are available. In addition, statistical methods are often used to control for variables thought to influence the relationship between two variables. If, for example, researchers want to know if the frequency of prenatal health care visits is related to the child's later IQ in children who were born prematurely, they may want to control for family income because of its known influence on IQ. Statistically controlling for family income simply means that the effect of income is held constant so that you can determine if the frequency of prenatal visits had an influence different from that contributed by family income. Although quasi-experimental designs have some limitations, careful design and replication can enhance confidence in the findings. When multiple studies over time support the relationship between variables, even when quasi-experimental designs are used, support is given to potential causal connections.

NONEXPERIMENTAL DESIGNS

Nonexperimental research designs are used when the independent variables cannot be manipulated. Nonexperimental designs include descriptive, exploratory, comparative, correlational, and developmental studies.[5] The phenomena nurses study are often naturally occurring events, which lend themselves to nonexperimental designs. In addition, before experimental designs can be used, it is often necessary to first explore possible relationships between variables and to identify differences between groups of subjects using nonexperimental methods. If developmental outcomes between children born prematurely and those born at full term do not differ, for example, there is no need to design an experiment to test the most effective intervention to improve developmental outcomes. Nonexperimental designs are therefore appropriate for exploratory studies.

INTERPRETATION AND USE OF FINDINGS

Regardless of the research design, clinicians must determine the appropriate interpretation and application of findings. Experimental, quasi-experimental, and nonexperimental designs can all suffer when validity is threatened. A study must be designed so that limitations are minimized whenever possible. When not possible, the researcher must identify limitations so that consumers of the research can make appropriate judgments about the usefulness of the findings. With careful design and implementation, all methods of research can result in data that contribute valuable scientific evidence.

The body of knowledge that a discipline generates over time serves as the basis for practice. Generally, no one study provides sufficient evidence upon which to base clinical judgments. An examination of the evidence from many studies using a variety of methods leads to confidence in practice decisions, however. The strongest evidence upon which to base practice decisions comes collectively from the different types of study design and from different disciplines.

SUMMARY

An experimental design is necessary for making cause-and-effect judgments about study variables. Although most researchers would agree that the experimental design is desirable, such a design is not possible or appropriate for every study—and even without an experimental design for support

of the hypothesis, enough evidence might exist for a researcher to feel somewhat comfortable that variable X causes Y. At the very least, it can be demonstrated that X is always related to Y in some number of settings, with multiple samples of subjects and with controls for as many variables as possible. Before deciding to change a practice based on research findings, however, the clinician must also determine if X is *not related* to Y in some cases. Without experimental findings, the amount and quality of evidence available must be considered.

This column has described three major types of research: experimental, quasi-experimental, and nonexperimental. Each type of research can produce valuable scientific evidence if the study is designed and implemented carefully. The type of research design and its appropriateness for the specific research question is only one consideration in critiquing research findings and making decisions about the application of those findings in practice settings. Future columns will address other considerations.

REFERENCES

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