A Clinician's Guide to Research Design

Gerald Goldstein

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Introduction

There seems to be a distinction in the health sciences and professions between researchers, who are basic scientists and rarely have contact with patients, and clinicians, who work directly with patients and generally do little if any research. At the hospital at which I work, an attempt has been made in recent years to break down this distinction. We try to get our research people to involve themselves with the ongoing clinical activities of the hospital, and correspondingly, we try to get the clinical people to do some research. Our experience has been that, while many clinicians have come up with excellent research ideas, they generally lack the tools needed to implement them. These tools consist of expertise in research design, research planning, getting the plan implemented, analyzing the obtained data, and writing reports. In doing research-consulting with clinical people, I have often wished that the basic material they needed to plan their projects was located somewhere in one place. There are several research design books and many statistics books, but without the necessary background it is difficult to go to just those sources that will help in solving a specific problem. I thought that a book written in nontechnical language and containing basic information about research design, planning, data analysis, and writing would be helpful in getting clinical people started with their projects. Another purpose of such a book would be to help individuals to evaluate research reports more intelligently, even if they do not do their own research.

This book is written for people who work in hospitals or other health related settings. Since I am a psychologist, most of the examples given will be taken from the behavioral sciences, but generalization to other areas can easily be made. Therefore, the

book should be of interest to physicians, nurses, pharmacists, dentists, and other medical and paramedical clinicians.

The book is in part a textbook and in part a reference book. It can be read through quickly as a general introduction to how research is done, or it can be used to look up the details of particular procedures. An individual who has had no formal training in research can use the book as an aid in converting his idea into an implementable research project. Much of the material presented in the book has not previously been put in writing. The sections on planning studies and the conduct of research are a part of the oral tradition of researchers, and while some of the points made are crucial to designing, organizing and carrying out a study, they aren't written down anywhere. I have tried to convey these concepts as directly as possible, in order that others may learn from my experiences and mistakes and those of other researchers.

The quantitative sections of the book are based on the assumption that many statistical procedures can be understood and used productively without knowing the underlying mathematical derivations. The point is to know what statistical test to use in what situation. I myself tend to become suspicious when a quantitatively oriented book is advertised as requiring no more than high school algebra, but I believe that the mathematical background needed for this book is minimal. On the other hand, I have not avoided particular procedures because they are too advanced mathematically. Thus, such areas as complex analysis of variance and factor analysis are covered as research tools. While no attempt is made to explain the mathematics of these procedures, they are described in terms of what they do, when they should and should not be used, and how they are interpreted. With the advent of computers, almost nobody would hand calculate a factor analysis anymore, but factor analysis can be an important clinical research tool and can be intelligently used by the non-mathematically erudite.

The unique feature of the book is that it covers, in the same work, all phases of the research process. It begins with how to design the exepriment and goes from there to how to collect the data and how to analyze the results.

The book is based on many years of experience in consulting with clinicians who want to do research but lack some aspects of the training and expertise needed to get their study organized. These individuals tend to have many questions in common. How do I test out my idea? Do I need a control group? How many subjects do I need? How do I analyze my data? The aim of this book is to try to briefly answer these questions. For those who need more detailed information than can be included here, we have included an annotated bibliography of books that cover in detail many of the areas we discuss in a brief, introductory way.

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Chapter 1

General Problems of Clinical Research

When most people think of research, they think of the laboratory as the setting in which it takes place. Indeed, the chemistry laboratory with its test tubes, benches, and assorted flasks of colored liquids probably forms the model for images most people conjure up when they think of scientific research. The scientists working in these laboratories generally look dignified and wear white coats. While such idyllic settings do exist they represent only one of a wide variety of situations in which research-related activities may take place. There is, for example, the field research of the archaeologist, geologist, or anthropologist, most of which takes place outside the laboratory in various natural settings. There is so-called action research, which has to do with scientific studies that accompany social action in real-life situations. The activity of clinical research, which is the focus of this book, is also frequently conducted outside the laboratory. The usual setting is some health service facility. While all scientists may adhere to a core of common principles and beliefs, the setting and situation in which scientific activity takes place create great variation with regard to the nature of that activity.

THE CLINICAL SETTING

The Three Polarities

The first portion of this chapter has to do with those variations associated with the clinical situation and setting. First, the characteristics of the clinical scientist will be discussed. The research situation always includes a scientist, and while scientists may all agree to general principles involving method and epistemology, they tend to differ greatly regarding theoretical and practical issues. Second, the matter of the setting will be taken up. Clinical settings or health service facilities are institutions with their own unique structures and goals and thereby exert an influence on the nature of the research carried on within their walls. Finally, there are the practical problems of doing clinical research, most of which are related to the fact that the subjects for such research are generally human beings, and usually human beings who are in poor health. This fundamental fact leads to a variety of ethical, methodological, substantive, and practical problems.

There are a number of adjectives commonly used to describe clinical research activity, with corresponding opposites used to characterize nonclinical research; clinical research is often described as "applied," "practical," or "pragmatic." Corresponding terms for nonclinical research are "pure," "basic," and "academic." Whether a scientist aligns himself with one set of these terms or the other has to do with three polarities in background and orientation. The first polarity relates to the scientist's training and may be called the "professional vs. scientific" dichotomy. While certain disciplines, notably psychology, have attempted to maintain a scientist-professional training model, most members of most disciplines find themselves to be more compatible with one of these roles than the other. However, both scientists and professionals may find themselves involved in research. Without undue stereotyping, it can be fairly said that scientifically trained researchers are oriented toward solutions of theoretical problems that may have no immediate applicability to patient care. Such researchers are well trained in the skills involved in doing research. They are generally conversant with the philosophy of science,

scientific method, and research design. Usually, they have one or more specific research skills such as knowledge of statistics, training in electronics and instrumentation, or knowledge and skill in the use of particular pieces of specialized scientific equipment. On the negative side, these individuals are generally lacking in clinical experience. They tend not to have dealt with patients, nor has their training led to any degree of expertise in diagnosis or treatment of disease.

Unlike the researcher with training as a scientist, professional researchers typically have not acquired specialized scientific skills. They may know little about research design and next to nothing about statistics. Again without undue stereotyping, their research interests involve solutions to problems of immediate clinical concern. Indeed, their research may have been stimulated by prior experiences with patients. In other words, the goal is usually not that of solution of a theoretical problem, but that of answering questions posed by particular sets of experiences with patients. A characteristic problem of the professionally trained researcher is that, while he or she may have some excellent ideas based on experiences with patients, the wherewithal for translating the ideas into research studies or experiments is lacking. Therefore, the professionally trained prospective researcher must generally go to a series of individuals with particular scientific skills for consultation.

A serious problem in clinical research is that the individuals who come up with the most significant ideas are frequently not those who are best equipped to follow their ideas through with a study or experiment. On the other hand, those best equipped to do research are often not exposed to clinical material that serves as a potent stimulus for generation of productive ideas. Two major consequences emerge from this dilemma. First, clinicians often go ahead and do studies based on their good ideas, but these studies are frequently poorly implemented and, thus, of little scientific merit. This unfortunate practice has tended to give clinical research something of a bad name. On the other hand, scientifically trained researchers often become involved in rather esoteric projects which do not contribute directly to solution of human problems. Such work has also received something of a bad name—in fact, such terms as "ivory tower," "irrelevant" and

"talmudic" are often applied to researchers and research of this type. The scholar in his isolated laboratory poring over his obscure data is often the object of sarcastic wit.

The second polarity is the "practical vs. theoretical" dichotomy. This issue is not so much one of training as it is one of values. Indeed, the individual's values in this area may influence the type of education he or she chooses. One major group of scientists maintains that the most productive approach to solution of human problems involves basic research into the fundamental processes involved in various phenomena. This position is seen, not only in the clinical realm, but throughout the sciences. Some geologists are interested in the origins of the universe; others want to find better methods of discovering oil. Some physicists are interested in designing nuclear reactors; others are concerned with the essential nature of matter. In the clinical area, theoretically oriented scientists believe that it will ultimately prove to be more productive to engage in basic studies of the life processes than to do applied studies directly related to the diagnosis or cure of specific diseases. For example, we have heard that the final cure for cancer will not come about until there is further understanding of cell metabolism.

More practically oriented scientists may agree in principle with the ultimate significance of basic research, but point to contemporary problems in need of immediate solution. These scientists point to the cures already found for certain kinds of cancer without the additional theoretical research called for by the basic scientists. In general, the practical group holds that partial solutions can be found through applied research and that such practical work need not await the more basic discoveries yet to be made. These more practically oriented individuals tend to be in clinical settings where they are moved by the presence of sick patients and the frustrations of their practitioner colleagues.

The problems this polarity poses for clinical research are exceedingly complex. Many of them have to do with failures of communication between the basic and applied scientists. They publish in different journals, have different language systems, and tend to work within different kinds of institutional settings. Thus, the applied researcher cannot always avail himself of potentially

useful knowledge discovered by the basic researcher. Correspondingly, the basic researcher may not keep abreast of findings in the clinical realm that may be of significance for his work. Problems also arise when the applied researcher cannot avail himself of skills and facilities to which the basic scientist has access. Likewise, the theoretical scientist has his troubles in that he often does not have access to the kinds of support frequently made available to the applied clinical researcher. In contemporary society, a research project with a quick "payoff" is often favored over the slower, more tedious experimentation characteristic of the basic scientist. Basically, the problems in this area tend to revolve more around sociological considerations within institutions than around questions of scientific merit. In the clinical institution the trend is toward support of researchers with a practical orientation, while in an academic setting, the reverse is more often the case.

There is also a "clinical vs. experimental" polarity, which in recent years has drawn much attention, particularly from the behavioral sciences. For example, much controversy and discussion has arisen since the publication of Paul Meehl's book, *Clinical Versus Statistical Prediction* (1954). The general question raised there relates to whether prediction can be made more accurately on the basis of trained clincial judgment or objective quantitative rules. A related issue involves opposing biases concerning the conduct of productive research. Some scientists adhere to the view that the best research utilizes established, objective, experimental procedures; others argue that clinical case studies, anecdotal observations, and related procedures are often an equally good if not better means of conducting scientific investigation. Some scientists are brought up in the experimental tradition and strongly favor the use of controlled laboratory studies, explicit specification of hypotheses and variables, and quantitative treatment of the obtained data. Other scientists criticize the artificiality of the laboratory setting, claim that premature specification of hypotheses and variables may inhibit exploration into potentially fruitful areas, and argue that nonquantitative means of data analysis, such as clincial interpretation, often point up important findings when quantitative approaches have failed to do so.

Clinical research runs into difficulties at both ends of this dichotomy in orientation. On the experimental side, the subject matter and circumstances surrounding much clinical research do not allow for maintenance of the more elegant experimental designs. Patients die during the course of the experiment or develop adverse reactions to the experimental procedures. Patients are discharged from the hospital before they can be put through all of the experimental conditions. Subjects meeting the criteria for inclusion in the sample are often not available in sufficient number. Thus, the experimental procedures developed in animal laboratories and in studies of college sophomores do not always work in hospitals and clinics. It is often necessary to compromise, much to the distaste of the experimentalist. However, the established methods can serve as standards and as goals to aim for in conducting research in clinical settings. When the walls are breached the influence of the "arch-clinician" is perhaps too strongly felt, with the danger that too much scientific rigor and objectivity may go by the board. The unfortunate result is that frequently an opinionated, insufficiently documented "clinical case study" will pass as scientific research. Thus, in caricature, we have the "hard-nosed experimentalist" who will not touch clinical research because of the impossibility of exercising satisfactory controls and of implementing established experimental designs vs. the "arch-clinician" who will not adhere in any way to established experimental procedures because they tend to hamper free exercise of clinical judgment and intuition. From the viewpoint of a behavioral scientist, the field of psychology reflects this polarization process in its history. At first, there was one psychology, but factions within it drifted apart so that now there is a clinical psychology and an experimental psychology that function in many respects as two distinct disciplines. Members of other disciplines may see this same kind of process in their own fields. Perhaps medicine has also undergone this development in the form of the emergence of the medical profession and the individual basic sciences of physiology, biochemistry, etc.

The three polarities are not independent. The researcher with scientific training generally tends to be theoretical and experi-

mental in orientation. The professionally trained individual likewise tends to gravitate toward the practical and clinical ends of the scale. This grouping of polarities tends to create problems for clinical research. Some tentatively proposed solutions will be presented in the last chapter of this book. At this point we only wish to indicate that the readers of this book as potential clinical researchers, are part of the problem. By virtue of your background and training, you are either scientifically or professionally oriented. By virtue of your values and needs, your aims are practical and immediate ones or involve the solution of theoretical problems, and by virtue of your beliefs you are inclined toward either clinical or experimental investigation. In effect, some of the problems of doing research in a clinical setting pertain to the personal characteristics of potential investigators. Some of the specific problems have been indicated: professionally trained investigators often lack expertise in scientific methodology; experimentally oriented investigators may be overly rigid in their desire to adhere strictly to established experimental procedures; clinically oriented investigators may be insufficiently aware of their lack of objectivity and their tendency to substitute opinion for scientific evidence. Other problems of this sort may become apparent upon reflection or in the course of working on a research task.

Problems Associated with Institutions at Which Clinical Research Takes Place

Science-fiction movies of the 1930s typically depicted scientists as having their laboratories in some well-concealed corner of their home, often an isolated castle. Apparently, research grants were unknown in those days, and so the scientist was usually portrayed as an independently wealthy individual who built his own laboratory and hired his research assistant, Igor, with his own financial resources. Needless to say, this pattern does not obtain in contemporary society. By and large, research takes place in large educational, scientific, or health service institutions. Most researchers are salaried employees and receive their support directly from the institution or from research grants awarded to it. It is the rare investigator indeed who can support his own research. As an

added note, very few researchers are independently wealthy and fewer still have assistants named Igor.

Researchers are typically institution dependent. The institution —be it a university, a private corporation, a hospital or a government agency—is the "boss" and provides the structure in which he or she works. It follows that the institution will influence the nature of the research work and how a researcher functions. In this section, we will deal only with the relationship between researchers and health service institutions, since the focus of this book is clinical research. Most clinical researchers work in university hospitals, in other large health service facilities, or in health-oriented research institutes. If they do not work directly for such institutions, they frequently work in them, since these settings provide access to patients. For example, an employee of a pharmaceutical firm may actually be carrying on his research with human subjects at some hospital or clinic. To limit our discussion further, we will only consider institutions at which there are major patient care programs. Health-related research institutes at which patients are admitted primarily for research purposes and only incidentally for treatment are not considered here since such institutions possess characteristics that generally do not obtain in more typical clinical settings.

Large treatment facilities, particulary those associated with universities, generally profess to perform a classical triumvirate of functions: patient care, education, and research. However, the relative proportions of each of these activities vary greatly, to the extent that in some settings the existence of one or more of them is merely nominal. In most cases, the weighting is in favor of the patient care function, for obvious reasons. Generally, education has second priority, particularly in hospitals and clinics that are affiliated with medical schools. Research may be a strong or a weak third. Attitudes toward research by institution policy makers tend to vary greatly. Some believe that the quality of patient care and educational programs are closely related to that of the research program; research is seen by such policy makers as an indispensable part of the facility's function. At the other end of the spectrum is the view that research is a luxury that may be dispensed with without impairing the overall quality level of the institution.