EDITORIAL

Six Points for Consideration in Conducting Research

As nuclear medicine matures, the investigative process requires greater sophistication, perception, aptitude, and capability. Basic to any research is an understanding of the research process, and this editorial addresses several points that should be considered.

The most difficult task facing a propsective research is the delineation of a researchable question. Only a few scientists are blessed with an issue clearly in mind that needs to be resolved and have the necessary resources and facilities required. Whether the project is well defined or is still in an embryonic form, the subject should be approached with the following questions in mind:

1. *What is the research question?* The question should be written down and examined word by word. Do some of the terms have different meanings for different people? It doesn't matter, for example, whether or not your definition of hypertension agrees with everyone else's so long as you state your definition and are prepared to maintain it. It would, however, help other researchers if you justify your definition, providing it is different from the accepted version; and, of course, it is much more useful in the comparison of your findings if your definitions are in agreement with the rest of the scientific community.

The research question can be stated as a hypothesis, which is nothing more than your personal prediction of the outcome of the research. In *most* instances the investigation will seek to compare two or more groups of animals or people, and the investigator will hypothesize differences between the groups involved. It is unlikely that any two groups will be exactly the same on any measured variable. If the difference turns out to be very slight, perhaps it occurred by chance. It will be necessary to decide when a "slight" difference becomes great enough to become an unlikely chance phenomenon. At this point the services of a biostatistician should be obtained. There are many factors that can influence this decision, but once the decision is made the statistician will assure us that the first step in determining whether an observed difference is or is not a likely chance occurrence is to *assume that no difference exists between the two groups with regard to the variable of interest.* That assumption is called the Null Hypothesis. It should therefore be possible to state the research hypothesis in the null—i.e., as a null hypothesis. Write this down and ask the question—"Is it logical?"

2. *What is the value and significance of the research question?* Consideration of this question forces one to deal with whether the research is basic or applied, which, in turn, may determine the possible sources of funding. At this point, also, a thorough review of the literature is required to determine the existing evidence that the question is presently unanswered, is answerable, and is of concern to the scientific community, or the economic community, or both.

3. *What data are needed to answer the research question?* One of the most worrisome practices is the gathering of data unrelated to the question. It is advisable that justification be offered for every bit of data to be gathered, and the argument that "...it may be of use someday" is *not* an acceptable justification. Gathering too much information frequently leads to the misuse of statistics, as well as a waste of a lot of time and energy. How will the data be displayed? Are there to be rates? If so, what is the denominator of such rates? Will the data be in the form of responses to questions? If so, how will these be analyzed?

4. *From what population (or universe) is the study sample to be drawn?* If the two groups under study are *not* samples, then any observed differences are real, and statistics assessing the

influence of chance on the observation are unnecessary. Ordinarily, however, researchers study samples of some larger population for the purpose of saying something about the population, *not* about the sample, therefore the sample must be representative of the population from which it is drawn. *How* the sample is selected is crucial to the entire experiment. A biostatistician or an epidemiologist should be consulted on this point.

5. *Is there a proper comparison population?* The comparison group should be comparable to the study group except in regard to the specific issue under study—i.e., the feature(s) believed to be responsible for differences that may be found. The sizes of the study group and of the comparison group are generally determined before the experiment begins, although there are designs that allow the size to vary as the data are examined. Many factors influence the size of these groups; practical considerations such as money and time must certainly be weighed, as well as the assessments of the importance of decisions based on the findings. One must be aware that small differences found between huge groups may have no practical meaning and yet be statistically significant. (This is why statistical tests of significance of differences are rarely done on census data, since very small differences between populations of millions would be statistically significant but mean little in the real world.) Likewise, practical extrapolations are often not possible from very small samples that are also subject to many statistical artefacts.

6. *Are the indices proposed to measure the variables within the level of expertise of the personnel making the measurements, and acceptable to the scientific community as repeatable (reliable), and valid—i.e., do they measure what they purport to measure?* Occasionally, a "trade-off" is necessary here, some indices being more reliable and less valid than others, or vice-versa. Again, the investigator's opinion is the determining factor, but this decision should be checked out with others in order to reach a considered judgment about the influence that the indices and their measurements may have on the outcome of the experiment.

After the data are gathered and analyzed and manuscript preparation is underway, the following should be considered: Once differences between groups are observed and chance has been found to be an unlikely explanation, it is natural to conclude that the hypothesis is valid and offers the best explanation for the differences. There may be, however, many other tenable explanations, and rejection of the null hypothesis—which only states that the difference is unlikely (by the investigator's definition) to be due to chance—does not render the explanation any more acceptable than a number of others, *unless it is possible now* to assess these influences as likely or unlikely. It is frequently important to include in the write-up a statement indicating awareness of possible alternative explanations, so that a reader will feel more comfortable with the eventual conclusions.

There are many other points for consideration in beginning, conducting, and assessing research activities. The points mentioned in this brief paper are the ones that seem most critical to the writers.

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