



Framing Research Question and Formulating Hypothesis for Testing: Critical Step in Research

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Abstract

Science is so dynamic that every moment some new advances are happening in each and every field. Medical science is also one of them. To keep pace with the advancements, we always need to update our knowledge to improve our decisions and actions relating to various aspects of medical science. A successful research will largely depend upon how well an investigator frames the research question. To comment upon the research with a degree of certainty, we need to develop a hypothesis, so that, it can be tested statistically by applying required tests of significance.

Keywords: Research question, Hypothesis, PICO, FINER.

Introduction

Science is so dynamic that every moment some new advances are happening in each and every field. Medical science is also one of them. To keep the pace with the advancements, we always need to update our knowledge to improve our decisions and actions relating to various aspects of medical science. Moreover, in medical practice, for some there may be a few unanswered issues and for others, experience might suggest trial of some alternative therapies. These situations may stimulate an individual to conduct a research. Our areas of research may also be varied and depend upon our role and level of expertise. These may be related to various aspects of healthcare, i.e., curative care, preventive care, improving delivery of healthcare services, modifying policy decisions, etc. If we want to address these issues scientifically, it becomes important for us to define our needs appropriately in the form of a research question. A successful research will largely depend upon how well an investigator frames the research question. Secondly, it is also equally important to convert a research question into a hypothesis. We can only answer the situation to a certain degree of statistical certainty. To comment upon the degree of certainty we need to develop a hypothesis so that it can be tested statistically by applying required tests of

significance. So framing a research question and converting it into a testable hypothesis is a very important and a challenging task.

Research Question Designing

For day-to-day care of patients, we require knowledge relating to different aspects of diseases/ health conditions. Sometimes we already know it and sometimes we have to acquire it. If we already possess the required knowledge, then only reinforcement is required which is termed as "cognitive resonance."¹ On the other hand, many times we face situations where we do not possess the required knowledge. In such situations, a response is created within ourselves, which is termed as "cognitive dissonance,"¹ i.e., we become aware that we need to acquire the concerned knowledge for delivering adequate care to the patient. Both these situations, i.e., cognitive resonance and cognitive dissonance act as motivating factors for learning and generating new research questions. We should design research questions by formulating queries/ questions that are answerable. It is the first step in any research. Questions which address our knowledge needs can be further classified into two types, i.e., background and foreground questions.²

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Background Questions

These are the basic questions which come to our mind during first interface with the situation. These questions are generally concerned to the general knowledge about the condition and would help us understand that condition in a better way. The questions may be related to various aspects of healthcare, i.e., curative care, preventive care, delivery of healthcare services, etc. These can involve various socio-demographic, biological, and psychological phenomena. Most of these are resolved by reviewing literature. A background question should have two components:

Question root: Who, what, when, why, how, when, etc. with a verb, and Health condition: Disease, event, test, treatment, healthcare delivery, etc.

For example, if we are looking at anemia among adolescents, then many questions can come to our mind like:

- What are the causes of anemia among adolescents?
- Do all adolescents with anemia present with the same symptoms?
- Who are at high risk of developing anemia?
- What is the daily requirement of iron in adolescents?
- What are the treatment modalities available? etc.

These are the basic questions which can be answered by our thorough reading of the topic. If any question remains unanswered, then it can be framed as the research question.

Foreground Questions

These are the questions which are important and knowing these will help us in making better decisions concerning specific situations including various clinical, biological, psychological, sociological issues related to health, e.g.,³⁻⁴

- What is the prevalence of anemia among adolescents?
- Whether the prevalence of anemia is similar among adolescent boys and girls?
- Whether the prevalence of anemia is similar among adolescents across different socio-economic groups?
- Is daily iron therapy more effective than bi-weekly iron therapy among adolescents? etc.

Questions/ queries usually arise in central issues around the clinical work like about clinical findings of the patient elicited through history or examination, etiology that is cause or risk factor for any disease, clinical manifestations of disease like when they appear in course of disease, differential diagnosis, diagnostic tests to exclude or confirm a diagnosis, prognosis like complications, therapy, i.e., which treatment to choose, prevention that is how risk factors can be modified, delivery of services to the community, i.e., how we can ensure a more economical and effective outreach of the services to the community, etc.

After defining the background and foreground questions, it is important to know the method of designing a good research question.

For this purpose, we can use different methods but one accepted method is using PICO criterion. The PICO format, i.e., population, intervention, control, and outcomes is a widely known strategy for framing "foreground" research questions. Sackett et al. pointed out that breaking the question into these four components will facilitate the identification of relevant information.⁵

PICO

- **Population or problem:** Specific population or problem of interest or specific patient situation
- **Intervention/ treatment of interest:** Any treatment, procedure, diagnostic test, risk or prognostic factor, any programme or policy
- **Comparison/ control:** Comparison with other technology or treatment like before and after studies
- **Outcome:** Should be easily quantifiable, specific, valid, reproducible, appropriate to question

For example, again taking the case of anemia among adolescents and breaking some of the above questions into PICO format. The question can be broken down as shown in the table.

We are doing so much of exercise to design different research questions, but at a given time we have limited resources to address these. It becomes very important for us to select the question which should be put forward for research. To optimize our efforts, we should be following the three recommended strategies, i.e., selecting, scheduling and saving these questions.

Table 1. The PICO format in different type of research questions

Question	P Population or problem	I Intervention/ Condition	C Comparison/ Control	O Outcome
What is the prevalence of anemia among adolescents?	Adolescents	Anemia	Non-anemia	Proportion of anemia
Whether the prevalence of anemia is similar among adolescent boys and girls?	Adolescents	Sex, i.e., anemia in boys	Anemia in girls	Difference in proportion of anemia
Is daily iron therapy more effective than bi-weekly iron therapy among adolescents?	Anemia among adolescents	Bi-weekly iron therapy	Daily iron therapy	Difference in proportion of anemia corrected

Selecting

As proposed by Hulley et al.⁶ we should use FINER (feasible, interesting, novel, ethical, and relevant) criteria for selecting the question to be pursued, i.e.,

- **Feasible:** Research question should address the issues which are feasible to be studied in terms of resources, i.e., manpower and cost;. Sometimes, a pilot study is done to check for feasibility. This may be sometimes difficult and guidance should be sought from mentors or the other experts in the field.⁷ This is important, so as to avoid wastage of resources, in case feasibility is not there.
- **Interesting:** Question should be interesting to develop passion and to get the attention of the reviewers.
- **Novel:** Novel topic arouses the interest of collaborators, colleagues and community.
- **Ethical:** Study should be ethical like it should not breach the confidentiality of patients or should not expose the subjects to harmful products.
- **Relevant:** Ideal research question should explain the specific problem to the point.

Scheduling

Scheduling of the question means that we should be deciding whether it is appropriate to have our question answered at this very time. We must also keep in mind when the resulting decisions need to be made; we need to be realistic in planning our questions as per time.

Many a time, we formulate a research question that is not feasible to be answered in the present scenario with available resources, or that focuses on the solution which is beyond the capacity of the system to act accordingly at that time, etc. We should be scheduling those questions for later.

Saving

It is very obvious that the unsaved questions become unanswered questions. So we must record the questions for later retrieval and searching. The best we record the questions, the most we will be saving our time in future. Moreover, recording of unanswered questions will encourage us constantly to find answers in future.

A well-formulated question is very important because of several reasons like:

- To complete research in the stipulated time by focusing directly on evidence relevant to patient's clinical needs and evidence which directly address our knowledge needs.
- A well-formulated question results in high yield search strategies and useful answers.
- Helps to understand the content in a better way, which is important for communication with the colleagues in case of referral and is also important for teaching.
- Most importantly after we get answer to our questions, our knowledge grows and cognitive resonance is restored.

Research Question and Hypothesis

A well-defined research question will lead the researcher to select an appropriate study design and methodology. Discussing research question with mentor/ biostatistician will help the conversion of research question into a hypothesis. A question can be scientifically investigated after converting it into a form of hypothesis. Hypothesis is an assumption that can be tested statistically and can be proved right or wrong.

Hypothesis can be defined as a logically conjectured estimation or association between two or more

variables expressed in the form of a testable statement. It is a specific statement of estimation, association, prediction, etc., and describes in concrete terms what is expected to happen in the study. It limits the area of research and keeps the researcher on the right track.

Types of Hypothesis

- **Null Hypothesis:** When a hypothesis is stated negatively, it is called a null hypothesis. It is a “no difference,” “no association” hypothesis, i.e., it states that no difference exists between the estimated and the real parameter statistic being compared to or no association exists between the variables being compared. It is usually represented as H^0 .
- **Alternate Hypothesis:** It is the hypothesis that describes the researcher's statement that there exists a difference in the estimated and the real parameter statistic being compared to, or there is some association between the two variables. It is the opposite of null hypothesis. It is represented as H^A .
For example, if we are finding the prevalence of anemia in adolescent girls in Delhi, then:
 - **Null Hypothesis:** There is no difference in prevalence of anemia in adolescent girls in Delhi and at national level.
 - **Alternate Hypothesis:** There exists a difference in national level prevalence of anemia in adolescent girls and prevalence in Delhi.

Conclusion

Up-gradation of knowledge is must to keep pace with the advancements which require lots of questions to be answered. For getting specific and correct answer to a specific question, it is necessary to have a good research

question. To design a good research question, PICO criteria is used and for selecting a question, FINER criteria is used. Scheduling and saving questions are also important to save time and other resources. A question can be scientifically investigated after converting it into a form of hypothesis, which can be proved right or wrong statistically.

Conflict of Interest: Nil

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