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The Basics of Dental Research Methodology

Dr. Nalini MS, PhD. Scholar, Professor, Department of Periodontology, Raja Rajeswari Dental College & Hospital, Mysore Road, Bangalore - 560074. E-mail: drnalinims79@gmail.com

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Abstract

The goal of the research is to expand our knowledge. Based on the insights obtained, decisions and choices can be made to organize our society. The need for scientific evidence should be the basis of clinical practice. Thus, the ultimate aim of oral health research must be to accomplish this. This article summarizes basic steps, types, and ethics in research methodology. This article also provides an overview of the study designs, how to identify a research problem, about basic framework for conducting research in Dentistry and also discusses report writing in dental research.

Keywords: Preresearch, Dental research, Research design, Steps in dental research, Basics of dental research

Introduction

Research is a methodology of science to develop, and learn new facts, and principles or contribute to generally applicable knowledge or new application of already known facts or principles. It is a venture to detect any new concepts something that was either never thought of or was in the domain of speculation or suspicion. The basic function of investigation is to answer the how and why of a circumstance and search for answers to what, when, how much, etc. The goal of dental research is to improve oral health, and the purpose is to learn how systems in the oral cavity work and maintain good oral health. It is a systematic process to better determine aetiology, pathophysiology, diagnosis, therapy and prognosis. Research is the very foundation of improved dental care. It can also provide evidence for policies and oral healthcare development decisions.

Sometimes dentistry use new material or instrument or on a new kind of drug to test its applicability to the new environment or on subject. This kind of confirmatory work is not an evident research but is accepted for postgraduate thesis because the objective is training.

Research is all about investigating and answering questions regarding the treatments and other areas of healthcare - trying to improve care by studying ways to make it more effective and efficient - developing new tests, treatments and procedures - looking for ways to prevent or reduce the risk of developing certain conditions - discovering how best to support people to manage their health and wellbeing. The use of research includes 1) Professional organizations that set “standards of care” 2) Politicians (“decision makers”) and 3) Dental health program managers. While the teachers and researchers are involved in conducting the research. The value of research for its own sake is limited. It is important to be able to justify the value of research to ensure that it receives the necessary funding and support. There are many ways to justify the value of research, including its potential to improve human health, advance knowledge, and improve the economy.¹

Steps in dental research

Science is known to be a systematic study that follows a pattern and does the job of predicting the outcome.

Scientific research must follow the scientific method, a step-by-step pathway that fosters clarity and avoids the problem of multiplicity. Systematic reviews are measured scientific investigations of primary studies and should be carried out according to a pre-defined plan to include all relevant articles, appropriate primary studies, and synthesized data.² These reviews will also help to develop new primary research,³ reducing bias and enabling researchers to reduce the ever-increasing volume of both published and unpublished articles into manageable summaries relating to specific clinical questions.⁴

Steps in dental research

- Identify The Problem
 - Literature Survey
 - Construct Working Hypotheses and Objectives
 - Develop A Research Design
 - Synopsis Writing
- PRE RESEARCH STEPS**
- Ethical Clearance
 - Development of Tools
 - Pilot Study or Pertest
 - Collecting The Data
 - Inspect The Collected Data
 - Analyse The Data
- RESEARCH STEPS**
- Hypothesis-Testing1
 - Result Interpretation1
 - Writing A Report or The Thesis
 - Revising Drafts
- POST RESEARCH STEPS**

Identify the problem

The preliminary step in the research is to identify the gap in a particular area of interest. This problem can be a question, a concern, or a controversy. One paradigm is that the unknown segment of the universe is much larger than the known segment. The existing clinical educational models place greater emphasis on clinical skills. However, these models do not effectively prepare students for the real-world clinical setting. The new clinical paradigm will provide students with the necessary skills to be successful in the real-world clinical setting. The dental research problem should address the research part regarding (a) relevance and applicability

for improving oral health in a larger population, (b) interest and expertise of your knowledge and to improve your dental collaborations, and (c) the practicability of ensuring the success of a study. All three of these aspects must be considered when designing the research. If any one of these is not given proper attention, the study may not be successful. These three aspects should substantially abate the problem area. If the condition permits, select a topic which is a current issue, that meets the current demand, and helps society to a larger extent.

Selection of topic should be related to something that needs oral health development, confirmation or disprove any developments. It must be well-defined and focused. It is necessary to consider several topics and choose the one that looks promising.⁵

The selected topic or problem should be transformed into specific questions that require an answer. The question should be relevant to the problem assessed. Smooth when this is completed with apparently necessary specificity, the course of the examination may reveal that individuals' questions were not so exact after all.

A good research question is backed by theoretical considerations. If the role of a particular type of membrane or graft for periodontal regeneration is being investigated, it is helpful to consider why that particular type of graft or membrane development can help in periodontal therapy. Novel approach or development gives a definite edge. Nevertheless, associations may exist for which sufficient causative mechanisms or materials are not understood; perhaps it emerges later. Research involving such novel materials /membranes are perfectly valid problems.

Literature survey

In this first phase of the project, focus is on understanding the problem identified. This will involve gathering as much information on the problem as possible and critically evaluating it. One major source of information for this project is the literature. The researcher should undertake an extensive literature survey about the problem at this juncture. For this purpose, abstracting and indexing journals and published or unpublished articles are the first place to look for. Former studies, if any, which are comparable to the study being dealt with should be carefully studied. But do not underestimate the potency of other sources. Secondary data might be available in various organisations that can enhance the focus of the problem. The thesis guide and the experts in

that particular field can provide useful insight with years of experience working in that area. Once the problem is formulated, a summary of it should be written down. A postgraduate or research scholar must submit a synopsis of the research proposal which must be approved by the Research Board before it can be submitted.⁵

Construct working hypotheses and objective

A working hypothesis is a preliminary proposal made to test empirical or logical consequences. Examine the data and records based on the problem, review analysis in the area or the studies on the same problems, and discuss with subject experts and colleagues about the problem, the objectives in looking for a solution and its origin. The objectives must contest the perceived utility of the results. For example, for the interventions being tested, objectives could be to determine the efficacy, affordability, safety, acceptability, etc. Identify specific aspect to formulate and concentrate on the research objectives consequently. But as a basic rule, the framing of working hypotheses is another basic step of the research process in most research problems.⁶

Develop a research design

In order to get a valid and reliable answer to the questions, or to get a solution to the problem, good research begins with a strategy. To develop a research design, we should consider how to obtain information, skills, the availability of the researchers, reasoning for selection, cost factor, and duration relating to research.

This requires⁵

- (i) Research purposes like if it is for Diagnosis, Description, Exploration, and Experimentation
- (ii) Decide sample design
- (iii) If observational study, look into prospective, retrospective or cross-sectional designs or specifics of intervention if required
- (iv) Tools to record information and determine the variables
- (v) Obtaining institutional ethical clearance
- (vi) Sampling methods
- (vii) Analysis of data (statistical analysis)

Do take expert advice from a biostatistician to develop an appropriate design.

Synopsis writing

A research synopsis is an abstract of a research project. It provides an overview of the research, the research objectives, the proposed methods for data collection, and the expected outcomes. It helps readers understand the research project and its purpose.

A synopsis is a summary of a larger work, and developing a synopsis is an important step in conducting research. Further deliberations may be needed to make the objectives and hypotheses more specific and to justify the strategy to be adopted.

Ethical clearance

Any study involving humans or animals needs approval from a Research Ethics Committee (Institutional Ethical Committee) before commencement of the research. The local application practice needs to be rigorously followed. Because Ethical approval often takes time, the researcher should anticipate this and allow sufficient time for the ethics assessment.

Development of tools

Tools for Dental Research are of two types. First is the proforma that is uniformly followed throughout the investigation, a recording questionnaire, and schedule. Second, are the investigation and measurement tools such as indices, for eg. indices to know oral health status is important to develop tools to help facilitate investigations and to provide information about what should be done in a laboratory. For some studies this may require procuring kits such as a periodontal diagnostic kit, eg. the Periotest[®]M which is a wireless electronic device for assessing parameters of periodontal disease. Arrangements may also have to be made which may include arranging for new material, and grafts, including membranes. The staff may need to be trained to use new equipment, to conduct examinations, or to use new laboratory methods so that valid and uniform data can be generated.

Pilot Study or pre-test

A pilot study is a trial run of the entire research protocol in a smaller scale. It is used to test the feasibility of the main study and make any necessary changes before proceeding. Conducting a pilot study can be very beneficial to obtain high-quality outcomes.^{7,8}

A pre-test study, which is a minor forerunner of the main investigation, also provides useful information regarding changes required in the quantities to be taken.

Collecting the data

Any dental research generates data, often in large quantities. The methodology must specify the method of collection and tabulation of data. The objective of this step is to collect the relevant data, but it also entails administering the intervention such as new dental material or graft for periodontal regeneration and observing the subjects. In a dental setup, the data are obtained by recording case history. There are diversified methods of data collection in a qualitative research, including textual or visual, observational, or through interviews, oral examination, physical examination, laboratory/ imaging investigations, or by combining these data-eliciting methods. The data quality will be monitored continuously to ensure proper data collection without bias. Who will record the data? Will, the data be collected in paper form or, these days, will direct computer entry be used? Samples of the recording forms, paper or computer program printout, must be included. The methods for the earlier decisions should be strictly followed. If the history could be obtained by interview, do not replace it with the patient records available. The data forms should be legibly and completely filled.

Inspect the collected data

Despite all the care taken while recording a patient's history, during oral examinations, and when performing radiographic investigations, errors can still occur. Successful implementation of a project is essential to ensure that the data collected is accurate and reliable. The researcher should plan and execute the project in a systematic and timely manner.

Analyse the data

First step of data analysis is preparing a master chart. The process of organizing data into a table is called tabulation. This can be done manually or with the use of a computer program. The data is typically organized into rows and columns, with each row or column representing a specific category. Tabulation is often used to make data more accessible and easier to understand. There are several computer programs available to help analyse the data collected. These can be divided into those designed for analysing quantitative data and those designed for analysing qualitative data. These programs are designed

to cover a wide range of statistical techniques and have many features that are unlikely to use. It is therefore best to work with someone familiar with the program. Analysing data that has already been tabulated generally consists of calculating percentages, coefficients, and other measures, using well-defined statistical formulas.

This involves administering appropriate statistical tests to evaluate significant differences, finding the structure of relationships such as regression and their significance, assessing trends and agreement, etc. A wise researcher devotes sufficient time to examine the data and for analysis. Collecting quality data is important in itself but exploiting it fully is even more important. New findings could sometime be missed despite the availability of appropriate data if not properly explored.⁶

Hypothesis-testing

Based on the data analysed, the researcher can test any hypotheses that were formulated earlier. Hypothesis testing can result in accepting or rejecting the hypothesis. If the researcher did not have any hypotheses to start with, simplifications based on the data may be stated as hypotheses to be tested by subsequent research. Consider an experiment testing the fluoride release of x dentifrice versus y dentifrice. Research question: Is there a difference in the release of fluoride between the x dentifrice and y dentifrice. Null Hypothesis: There is no difference in the release of fluoride between the two dentifrices. Alternate Hypothesis: There is a difference in fluoride release between x and y dentifrices. We aim to test the fluoride release in a selected sample and this sample is only a representation of the bigger population or the truth. Hence, before testing the hypothesis, we need to take a step back and analyse the key components that go into hypothesis testing.⁶

Result interpretation

The value of research depends on its skill to test hypotheses and arrive at generalisations. If a hypothesis is repeatedly upheld, the researcher may be able to build a theory. If the researcher had no hypothesis to start with, he might seek to explain his findings based on some theory - a process known as interpretation. This may in turn trigger new questions and lead to further research.

A series of steps can be suggested during interpretation.

(i) Examination of results in the background of the questions that prompted the research. (ii) Verify if all

the results are consistent with one another and proper clarification is available for the unpredictable ones. (iii) All the potential biases have to be checked or either ruled out by design. (iv) Assess the dependability of the results. They must be reproducible. (v) Confirm using a proper biological explanation available. (vi) Show by evident analysis and ambiguity analysis that the results are robust to the systematic variations. (vii) Ensure that the conclusions derived are indeed a novel development and not a repeat of previous knowledge. You should be influenced by the correctness of the conclusions and there should be enough reasons to convince others. Results should not be speculative but based on evidence as revealed by the data and other facts. If the results are too good to believe, re-examine them.⁵

Writing a report or thesis

The researcher has to prepare a report considering the following.

The report layout should have

- A) Preliminary page should have – 1. a title and date, 2. acknowledgements, 3. foreword, 4. table of contents, 5. list of tables, and 6. lists of graphs and charts.
- B) The main text of the report should have the following parts:
 - (a) Introduction
 - (b) Summary of findings
 - (c) Main report

The main body of the report should be presented in a logical sequence.

- (d) Conclusion

Towards the end of the main text, the researcher should again put down the results of his research clearly and precisely. It is the final summing up.

- C) At the end of the report

Appendices, a bibliography, and an index should be included in all research reports.⁶

The report should be detailed enough to remove any doubt a reader might have about any aspect of the results. The paper should be properly written, with a clear demarcation between evidence-based results and opinions/comments.⁵

The report should be sufficiently depicted with diagrams to provide clarity.

Numerical results can be summarized in the form of tables.

Describe all the limitations honestly.

No result will be universally applicable, and the scientific community is fully aware of this fact. Thus the limitations should be stated without hesitation.⁵

Revising drafts

Revising drafts is necessary, in terms of content, structure, or the style. Look for disparities between the statements in the text and data presented in tables or figures. Ensure that there is continuity in the use of terms and that the full version of all abbreviations is given when used for the first time. For example, Periodontal Screening Index (PSI), should appear when first used in a paper, and then the abbreviation 'PSI' can be used in the remaining of the paper.

To ensure an objective style, narration done as third person and simple past tense can be used consistently throughout the paper. The first person used suggests a degree of subjectivity and the second person is one of condescension, which should be avoided. If reference manager software has not been used, the references should remain in the Harvard style, both in the text and in the references list, until the final stage. If the journal to which the paper is being submitted requires, then the references should be converted to Vancouver style. If the journal to which the paper is submitted publishes a checklist for reviewers, the author(s) should go through the draft with the checklist to help identify any errors or omissions. When the author(s) are satisfied with the final draft, it is wise to ask a colleague who is knowledgeable about manuscript writing to read it before submission.⁹

Researchers in India face many problems

1. Our country's lack of scientific training in research methodology is a great impediment for researchers.
2. Insufficient interaction exists between the university research departments and businesses, government departments, and research institutions.
3. Many businesses in our country lack confidence that the material they provide to researchers will not be misused. As a result, they are often cautious to supply the necessary information to researchers.

4. Research studies overlapping often results in duplication and wasting of resources.
5. Code of conduct does not exist for inter-university and researchers and interdepartmental rivalries are also quite common.
7. Many researchers report unsatisfactory library management and functioning, often spending longer time trying to locate books, journals, reports, etc., than finding relevant material.
9. The study also has some limitations. Firstly, the data was collected from various sources which might not be comparable. Secondly, the data was collected for a period of five years which might not be sufficient to do an in-depth analysis.
10. The problem of conceptualization and data collection may arise from time to time.⁶

Results of dental research

The eventual goal of oral health research is to improve oral health and related factors. This can be achieved with dental research conducted with conscience and dedication. Sometimes the results can be so strong that they improve the well-being of a large segment of population. Ideally, prevention of disease, treatment of existing disease and the organization of care delivery should be based on high-level evidence obtained from high-quality research. Even though research that improves the quality of life of just one patient is expensive and worth society's effort, efforts are concentrated more on aspects that benefit a great number of people.

Dental research has been very illuminating and has brought abundant cheers to individuals and society. Despite the major emphasis these days on methodological aspects, it is predicted that future research would be more efficient, and can benefit a larger segment of the population at a lower cost. You could be an important contributor to these efforts by following simple rules elaborated in this text.

Conflicts of Interest

Nil

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