The critical steps for successful research: The research proposal and scientific writing

(A report on the pre-conference workshop held in conjunction with the 64th annual conference of the Indian Pharmaceutical Congress-2012)

Pitchai Balakumar, Mohammed Naseeruddin Inamdar[1], Gowraganahalli Jagadeesh[2]

Pharmacology Unit, Faculty of Pharmacy, AIMST University, Semeling, 08100 Bedong. Kedah Darul Aman, Malaysia, [1]Department of Pharmacology, Al-Ameen College of Pharmacy, Bengaluru, Karnataka, India [2]Division of Cardiovascular and Renal Products, Center for Drug Evaluation and Research, US Food and Drug Administration, Silver Spring, USA

ABSTRACT

An interactive workshop on 'The Critical Steps for Successful Research: The Research Proposal and Scientific Writing' was conducted in conjunction with the 64th Annual Conference of the Indian Pharmaceutical Congress-2012 at Chennai, India. In essence, research is performed to enlighten our understanding of a contemporary issue relevant to the needs of society. To accomplish this, a researcher begins search for a novel topic based on purpose, creativity, critical thinking, and logic. This leads to the fundamental pieces of the research endeavor: Question, objective, hypothesis, experimental tools to test the hypothesis, methodology, and data analysis. When correctly performed, research should produce new knowledge. The four cornerstones of good research are the well-formulated protocol or proposal that is well executed, analyzed, discussed and concluded. This recent workshop educated researchers in the critical steps involved in the development of a scientific idea to its successful execution and eventual publication.

Key words: Research protocol, scientific writing, creativity, publication ethics,

INTRODUCTION

Creativity and critical thinking are of particular importance in scientific research. Basically, research is original investigation undertaken to gain knowledge and understand concepts in major subject areas of specialization, and includes the generation of ideas and information leading to new or substantially improved scientific insights with relevance to the needs of society. Hence, the primary objective of research is to produce new knowledge. Research is both theoretical and empirical. It is theoretical because the starting point of scientific research is the conceptualization of a research topic and development of a research question and hypothesis. Research is empirical (practical) because all of the planned studies involve a series of observations, measurements, and analyses of data that are all based on proper experimental design.[1-9]

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The subject of this report is to inform readers of the proceedings from a recent workshop organized by the 64th Annual conference of the '*Indian Pharmaceutical Congress*' at SRM University, Chennai, India, from 05 to 06 December 2012. The objectives of the workshop titled 'The Critical Steps for Successful Research: The Research Proposal and Scientific Writing,' were to assist participants in developing a strong fundamental understanding

Address for correspondence:
Gowraganahalli Jagadeesh, Division of Cardiovascular and Renal Products, Food and Drug Administration, 10903 New Hampshire Ave, Bldg 22, Rm 4128, Silver Spring, MD 20993-0002, USA. E-mail: gowra.jagadeesh@fda.hhs.gov

of how best to develop a research or study protocol, and communicate those research findings in a conference setting or scientific journal. Completing any research project requires meticulous planning, experimental design and execution, and compilation and publication of findings in the form of a research paper. All of these are often unfamiliar to naïve researchers; thus, the purpose of this workshop was to teach participants to master the critical steps involved in the development of an idea to its execution and eventual publication of the results (See the last section for a list of learning objectives).

THE STRUCTURE OF THE WORKSHOP

The two-day workshop was formatted to include key lectures and interactive breakout sessions that focused on protocol development in six subject areas of the pharmaceutical sciences. This was followed by sessions on scientific writing. DAY 1 taught the basic concepts of scientific research, including: (1) how to formulate a topic for research and to describe the *what, why,* and *how* of the protocol, (2) biomedical literature search and review, (3) study designs, statistical concepts, and result analyses, and (4) publication ethics. DAY 2 educated the attendees on the basic elements and logistics of writing a scientific paper and thesis, and preparation of poster as well as oral presentations.

The final phase of the workshop was the 'Panel Discussion,' including 'Feedback/Comments' by participants. There were thirteen distinguished speakers from India and abroad. Approximately 120 post-graduate and pre-doctoral students, young faculty members, and scientists representing industries attended the workshop from different parts of the country. All participants received a printed copy of the workshop manual and supporting materials on statistical analyses of data.

THE BASIC CONCEPTS OF RESEARCH: THE KEY TO GETTING STARTED IN RESEARCH

A research project generally comprises four key components: (1) writing a protocol, (2) performing experiments, (3) tabulating and analyzing data, and (4) writing a thesis or manuscript for publication.

Fundamentals in the research process

A protocol, whether experimental or clinical, serves as a navigator that evolves from a basic outline of the study plan to become a qualified research or grant proposal. It provides the structural support for the research. Dr. G. Jagadeesh (US FDA), the first speaker of the session, spoke on '*Fundamentals in research process and cornerstones of a research project.*' He discussed at length the developmental and structural processes in preparing a research protocol. A systematic and step-by-step approach is necessary in planning a study. Without a well-designed protocol, there would be a little chance for successful completion of a research project or an experiment.

Research topic

The first and the foremost difficult task in research is to identify a topic for investigation. The research topic is the keystone of the entire scientific enterprise. It begins the project, drives the entire study, and is crucial for moving the project forward. It dictates the remaining elements of the study [Table 1] and thus, it should not be too narrow or too broad or unfocused. Because of these potential pitfalls, it is essential that a good or novel scientific idea be based on a sound concept. Creativity, critical thinking, and logic are required to generate new concepts and ideas in solving a research problem. Creativity involves critical thinking and is associated with generating many ideas. Critical thinking is analytical, judgmental, and involves evaluating choices before making a decision.[4] Thus, critical thinking is convergent type thinking that narrows and refines those divergent ideas and finally settles to one idea for an in-depth study. The idea on which a research project is built should be novel, appropriate to achieve within the existing conditions, and useful to the society at large. Therefore, creativity and critical thinking assist biomedical scientists in research that results in funding support, novel discovery, and publication.[1,4]

Research question

The next most crucial aspect of a study protocol is identifying a research question. It should be a thought-provoking question. The question sets the framework. It emerges from the title, findings/results, and problems observed in previous studies. Thus, mastering the literature, attendance at conferences, and discussion in journal clubs/seminars are sources for developing research questions. Consider the following example in developing related research questions from the research topic.

- Topic
  Hepatoprotective activity of *Terminalia arjuna* and *Apium graveolens* on paracetamol-induced liver damage in albino rats.

Table 1: Elements of a study protocol

Element	Purpose
Research topic*	Keystone of the study. Begins, drives, and ends the study
Research question*	Relationship between two or more variables is phrased as a question
Objective*	Researchable issue. Developed logically from a description of the topic
Hypothesis*	Relationship phrased as a declarative statement, needs statistical testing
Significance of the study	Why is the research question important? What are the implications of the study?
Experimental design	Materials and methods, subjects, variables, statistics

*Considered cornerstones of a research project

- Research questions
  How is paracetamol metabolized in the body? Does it involve P450 enzymes? How does paracetamol cause liver injury? What are the mechanisms by which drugs can alleviate liver damage? What biochemical parameters are indicative of liver injury? What major endogenous inflammatory molecules are involved in paracetamol-induced liver damage?

Objective

A research question is broken down into more precise objectives. The objectives lead to more precise methods and definition of key terms. The objectives should be SMART-Specific, Measurable, Achievable, Realistic, Time-framed,[10] and should cover the entire breadth of the project. The objectives are sometimes organized into hierarchies: Primary, secondary, and exploratory; or simply general and specific. Study the following example:

- Primary objective
  To evaluate the safety and tolerability of single oral doses of compound X in normal volunteers.
- Secondary objective
  To assess the pharmacokinetic profile of compound X following single oral doses.
- Exploratory objective
  To evaluate the incidence of peripheral edema reported as an adverse event.

Hypothesis

The objectives and research questions are then formulated into a workable or testable hypothesis. The latter forces us to think carefully about what comparisons will be needed to answer the research question, and establishes the format for applying statistical tests to interpret the results. The hypothesis should link a process to an existing or postulated biologic pathway. A hypothesis is written in a form that can yield measurable results. Studies that utilize statistics to compare groups of data should have a hypothesis. Consider the following example:

- The hepatoprotective activity of *Terminalia arjuna* is superior to that of *Apium graveolens* against paracetamol-induced liver damage in albino rats.

All biological research, including discovery science, is hypothesis–driven. However, not all studies need be conducted with a hypothesis. For example, descriptive studies (e.g., describing characteristics of a plant, or a chemical compound) do not need a hypothesis.[1]

Relevance of the study

Another important section to be included in the protocol is 'Significance of the study.' Its purpose is to justify the need for the research that is being proposed (e.g., development of a vaccine for a disease). In summary, the proposed study should demonstrate that it represents an advancement in understanding and that the eventual results will be meaningful, contribute to the field, and possibly even impact society.

Biomedical literature

A literature search may be defined as the process of examining published sources of information on a research or review topic, thesis, grant application, chemical, drug, disease, or clinical trial, etc. The quantity of information available in print or electronically (e.g., the internet) is immense and growing with time. A researcher should be familiar with the right kinds of databases and search engines to extract the needed information.[3,6]

Dr. P. Balakumar (Institute of Pharmacy, Rajendra Institute of Technology and Sciences, Sirsa, Haryana; currently, Faculty of Pharmacy, AIMST University, Malaysia) spoke on '*Biomedical literature: Searching, reviewing and referencing.*' He schematically explained the basis of scientific literature, designing a literature review, and searching literature. After an introduction to the genesis and diverse sources of scientific literature searches, the use of PubMed, one of the premier databases used for biomedical literature searches world-wide, was illustrated with examples and screenshots. Several companion databases and search engines are also used for finding information related to health sciences, and they include Embase, Web of Science, SciFinder, The Cochrane Library, International Pharmaceutical Abstracts, Scopus, and Google Scholar.[3] Literature searches using alternative interfaces for PubMed such as GoPubMed, Quertle, PubFocus, Pubget, and BibliMed were discussed. The participants were additionally informed of databases on chemistry, drugs and drug targets, clinical trials, toxicology, and laboratory animals (reviewed in ref[3]).

Referencing and bibliography are essential in scientific writing and publication.[7] Referencing systems are broadly classified into two major types, such as Parenthetical and Notation systems. Parenthetical referencing is also known as Harvard style of referencing, while Vancouver referencing style and 'Footnote' or 'Endnote' are placed under Notation referencing systems. The participants were educated on each referencing system with examples.

Bibliography management

Dr. Raj Rajasekaran (University of California at San Diego, CA, USA) enlightened the audience on '*bibliography management*' using reference management software programs such as Reference Manager®, Endnote®, and Zotero® for creating and formatting bibliographies while writing a manuscript for publication. The discussion focused on the use of bibliography management software in avoiding common mistakes such as incomplete references. Important steps in bibliography management, such as creating reference libraries/

databases, searching for references using PubMed/Google scholar, selecting and transferring selected references into a library, inserting citations into a research article and formatting bibliographies, were presented. A demonstration of Zotero®, a freely available reference management program, included the salient features of the software, adding references from PubMed using PubMed ID, inserting citations and formatting using different styles.

Writing experimental protocols

The workshop systematically instructed the participants in writing '*experimental protocols*' in six disciplines of Pharmaceutical Sciences.: (1) Pharmaceutical Chemistry (presented by Dr. P. V. Bharatam, NIPER, Mohali, Punjab); (2) Pharmacology (presented by Dr. G. Jagadeesh and Dr. P. Balakumar); (3) Pharmaceutics (presented by Dr. Jayant Khandare, Piramal Life Sciences, Mumbai); (4) Pharmacy Practice (presented by Dr. Shobha Hiremath, Al-Ameen College of Pharmacy, Bengaluru); (5) Pharmacognosy and Phytochemistry (presented by Dr. Salma Khanam, Al-Ameen College of Pharmacy, Bengaluru); and (6) Pharmaceutical Analysis (presented by Dr. Saranjit Singh, NIPER, Mohali, Punjab). The purpose of the research plan is to describe the *what* (Specific Aims/Objectives), *why* (Background and Significance), and *how* (Design and Methods) of the proposal.

The research plan should answer the following questions: (a) what do you intend to do; (b) what has already been done in general, and what have other researchers done in the field; (c) why is this worth doing; (d) how is it innovative; (e) what will this new work add to existing knowledge; and (f) how will the research be accomplished?

In general, the format used by the faculty in all subjects is shown in Table 2.

Table 2: Elements of a research protocol

Title (short and effective)
Introduction (should answer 'what' and 'why' of the proposal (should list research questions, objectives of the study); this should be followed by (a separate paragraph) 'the central hypothesis that would be tested '
Review of literature (existing knowledge in the area of work, the rationale for the proposed project, and the gaps that the project is intended to fill). The review should be logically organized and should include a discussion of major variables that are measured in the research
Significance of research (what is expected from the work, why the expected outcomes are potentially important in advancing the field, study impact)
Plan of study (how the research will be carried out/work plan with timeline)
General methodology (based on the plan of study). List each method separately and give the chemicals/instruments you intend to use in each case
References (Bibliography). Follow a proper style, be consistent, and no mix and match

Biostatistics

Biostatistics is a key component of biomedical research. Highly reputed journals like The Lancet, BMJ, Journal of the American Medical Association, and many other biomedical journals include biostatisticians on their editorial board or reviewers list. This indicates that a great importance is given for learning and correctly employing appropriate statistical methods in biomedical research. The post-lunch session on day 1 of the workshop was largely committed to discussion on '*Basic biostatistics.'* Dr. R. Raveendran (JIPMER, Puducherry) and Dr. Avijit Hazra (PGIMER, Kolkata) reviewed, in parallel sessions, descriptive statistics, probability concepts, sample size calculation, choosing a statistical test, confidence intervals, hypothesis testing and '*P*' values, parametric and non-parametric statistical tests, including analysis of variance (ANOVA), t tests, Chi-square test, type I and type II errors, correlation and regression, and summary statistics. This was followed by a practice and demonstration session. Statistics CD, compiled by Dr. Raveendran, was distributed to the participants before the session began and was demonstrated live. Both speakers worked on a variety of problems that involved both clinical and experimental data. They discussed through examples the experimental designs encountered in a variety of studies and statistical analyses performed for different types of data. For the benefit of readers, we have summarized statistical tests applied frequently for different experimental designs and *post-hoc* tests [Figure 1].

Research and publication ethics

The legitimate pursuit of scientific creativity is unfortunately being marred by a simultaneous increase in scientific misconduct. A disproportionate share of allegations involves scientists of many countries, and even from respected laboratories. Misconduct destroys faith in science and scientists and creates a hierarchy of fraudsters. Investigating misconduct also steals valuable time and resources. In spite of these facts, most researchers are not aware of publication ethics.

Day 1 of the workshop ended with a presentation on '*research and publication ethics*' by Dr. M. K. Unnikrishnan (College of Pharmaceutical Sciences, Manipal University, Manipal). He spoke on the essentials of publication ethics that included plagiarism (attempting to take credit of the work of others), self-plagiarism (multiple publications by an author on the same content of work with slightly different wordings), falsification (manipulation of research data and processes and omitting critical data or results), gift authorship (guest authorship), ghostwriting (someone other than the named author (s) makes a major contribution), salami publishing (publishing many papers, with minor differences, from the same study), and sabotage (distracting the research works of others to halt their research completion). Additionally, Dr. Unnikrishnan pointed out the '*Ingelfinger*

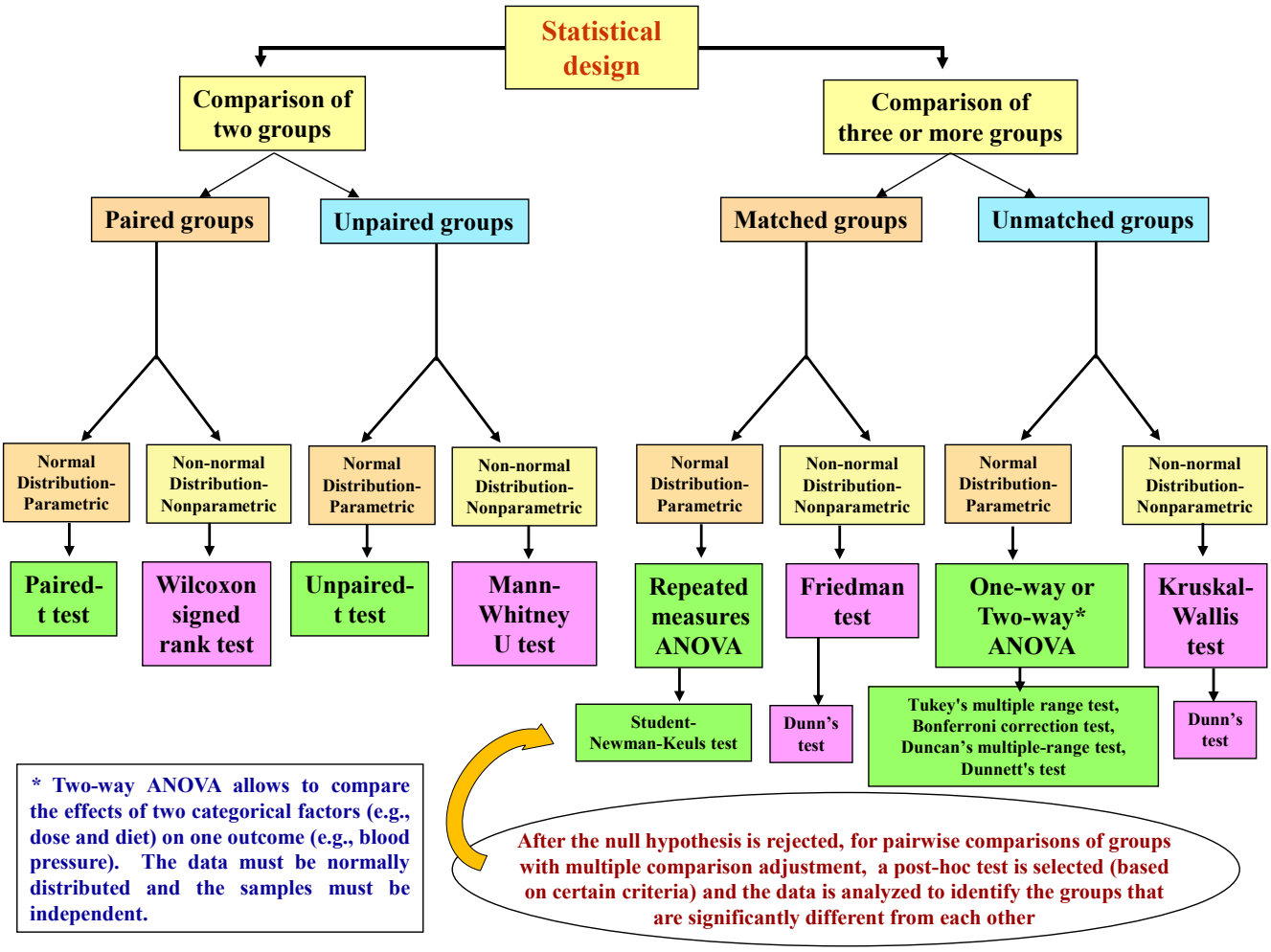

Figure 1: Conceptual framework for statistical analyses of data. Of the two kinds of variables, qualitative (categorical) and quantitative (numerical), qualitative variables (nominal or ordinal) are not normally distributed. Numerical data that come from normal distributions are analyzed using parametric tests, if not; the data are analyzed using non-parametric tests. The most popularly used Student's *t*-test compares the means of two populations, data for this test could be paired or unpaired. One-way analysis of variance (ANOVA) is used to compare the means of three or more independent populations that are normally distributed. Applying *t* test repeatedly in pair (multiple comparison), to compare the means of more than two populations, will increase the probability of type I error (false positive). In this case, for proper interpretation, we need to adjust the *P* values. Repeated measures ANOVA is used to compare the population means if more than two observations coming from same subject over time. The null hypothesis is rejected with a *'P'* value of less than 0.05, and the difference in population means is considered to be statistically significant. Subsequently, appropriate *post-hoc* tests are used for pairwise comparisons of population means. Two-way or three-way ANOVA are considered if two (diet, dose) or three (diet, dose, strain) independent factors, respectively, are analyzed in an experiment (not described in the Figure). Categorical nominal unmatched variables (counts or frequencies) are analyzed by Chi-square test (not shown in the Figure)

rule' of stipulating that a scientist must not submit the same original research in two different journals. He also advised the audience that authorship is not just credit for the work but also responsibility for scientific contents of a paper. Although some Indian Universities are instituting preventive measures (e.g., use of plagiarism detecting software, Shodhganga digital archiving of doctoral theses), Dr. Unnikrishnan argued for a great need to sensitize young researchers on the nature and implications of scientific misconduct. Finally, he discussed methods on how editors and peer reviewers should ethically conduct themselves while managing a manuscript for publication.

SCIENTIFIC COMMUNICATION: THE KEY TO SUCCESSFUL SELLING OF FINDINGS

Research outcomes are measured through quality publications. Scientists must not only 'do' science but must 'write' science. The story of the project must be told in a clear, simple language weaving in previous work done in the field, answering the research question, and addressing the hypothesis set forth at the beginning of the study. Scientific publication is an organic process of planning, researching, drafting, revising, and updating the current knowledge for future perspectives. Writing a research paper is no easier than the research itself. The lectures of *Day 2*

of the workshop dealt with the basic elements and logistics of writing a scientific paper.

An overview of paper structure and thesis writing

Dr. Amitabh Prakash (Adis, Auckland, New Zealand) spoke on '*Learning how to write a good scientific paper.*' His presentation described the essential components of an original research paper and thesis (e.g., introduction, methods, results, and discussion [IMRaD]) and provided guidance on the correct order, in which data should appear within these sections. The characteristics of a good abstract and title and the creation of appropriate key words were discussed. Dr. Prakash suggested that the 'title of a paper' might perhaps have a chance to make a good impression, and the title might be either indicative (title that gives the purpose of the study) or declarative (title that gives the study conclusion). He also suggested that an abstract is a succinct summary of a research paper, and it should be specific, clear, and concise, and should have IMRaD structure in brief, followed by key words. Selection of appropriate papers to be cited in the reference list was also discussed. Various unethical authorships were enumerated, and 'The International Committee of Medical Journal Editors (ICMJE) criteria for authorship' was explained (http://www.icmje.org/ethical_1author.html; also see Table 1 in reference **#9**). The session highlighted the need for transparency in medical publication and provided a clear description of items that needed to be included in the 'Disclosures' section (e.g., sources of funding for the study and potential conflicts of interest of all authors, etc.) and 'Acknowledgements' section (e.g., writing assistance and input from all individuals who did not meet the authorship criteria). The final part of the presentation was devoted to thesis writing, and Dr. Prakash provided the audience with a list of common mistakes that are frequently encountered when writing a manuscript.

The backbone of a study is description of results through Text, Tables, and Figures. Dr. S. B. Deshpande (Institute of Medical Sciences, Banaras Hindu University, Varanasi, India) spoke on '*Effective Presentation of Results.*' The Results section deals with the observations made by the authors and thus, is not hypothetical. This section is subdivided into three segments, that is, descriptive form of the Text, providing numerical data in Tables, and visualizing the observations in Graphs or Figures. All these are arranged in a sequential order to address the question hypothesized in the Introduction. The description in Text provides clear content of the findings highlighting the observations. It should not be the repetition of facts in tables or graphs. Tables are used to summarize or emphasize descriptive content in the text or to present the numerical data that are unrelated. Illustrations should be used when the evidence bearing on the conclusions of a paper cannot be adequately presented in a written description or in a Table. Tables or Figures should relate to each other logically in sequence and should be clear by themselves. Furthermore, the discussion is based entirely on these observations. Additionally, how the results are applied to further research in the field to advance our understanding of research questions was discussed.

Dr. Peush Sahni (All-India Institute of Medical Sciences, New Delhi) spoke on effectively '*Structuring the Discussion*' for a research paper. The Discussion section deals with a systematic interpretation of study results within the available knowledge. He said the section should begin with the most important point relating to the subject studied, focusing on key issues, providing link sentences between paragraphs, and ensuring the flow of text. Points were made to avoid history, not repeat all the results, and provide limitations of the study. The strengths and novel findings of the study should be provided in the discussion, and it should open avenues for future research and new questions. The Discussion section should end with a conclusion stating the summary of key findings. Dr. Sahni gave an example from a published paper for writing a Discussion. In another presentation titled '*Writing an effective title and the abstract,*' Dr. Sahni described the important components of a good title, such as, it should be simple, concise, informative, interesting and eye-catching, accurate and specific about the paper's content, and should state the subject in full indicating study design and animal species. Dr. Sahni explained structured (IMRaD) and unstructured abstracts and discussed a few selected examples with the audience.

Language and style in publication

The next lecture of Dr. Amitabh Prakash on '*Language and style in scientific writing: Importance of terseness, shortness and clarity in writing*' focused on the actual sentence construction, language, grammar and punctuation in scientific manuscripts. His presentation emphasized the importance of brevity and clarity in the writing of manuscripts describing biomedical research. Starting with a guide to the appropriate construction of sentences and paragraphs, attendees were given a brief overview of the correct use of punctuation with interactive examples. Dr. Prakash discussed common errors in grammar and proactively sought audience participation in correcting some examples. Additional discussion was centered on discouraging the use of redundant and expendable words, jargon, and the use of adjectives with incomparable words. The session ended with a discussion of words and phrases that are commonly misused (e.g., data *vs.* datum, affect *vs.* effect, among *vs.* between, dose *vs.* dosage, and efficacy/efficacious *vs.* effective/effectiveness) in biomedical research manuscripts.

Working with journals

The appropriateness in selecting the journal for submission and acceptance of the manuscript should be determined by the experience of an author. The corresponding author must have a rationale in choosing the appropriate journal, and this depends upon the scope of the study and the quality of work performed.

Dr. Amitabh Prakash spoke on '*Working with journals: Selecting a journal, cover letter, peer review process and impact factor*' by instructing the audience in assessing the true value of a journal, understanding principles involved in the peer review processes, providing tips on making an initial approach to the editorial office, and drafting an appropriate cover letter to accompany the submission. His presentation defined the metrics that are most commonly used to measure journal quality (e.g., impact factor™, Eigenfactor™ score, Article Influence™ score, SCOPUS 2-year citation data, SCImago Journal Rank, h-Index, etc.) and guided attendees on the relative advantages and disadvantages of using each metric. Factors to consider when assessing journal quality were discussed, and the audience was educated on the 'green' and 'gold' open access publication models. Various peer review models (e.g., double-blind, single-blind, non-blind) were described together with the role of the journal editor in assessing manuscripts and selecting suitable reviewers. A typical checklist sent to referees was shared with the attendees, and clear guidance was provided on the best way to address referee feedback. The session concluded with a discussion of the potential drawbacks of the current peer review system.

Poster and oral presentations at conferences

Posters have become an increasingly popular mode of presentation at conferences, as it can accommodate more papers per meeting, has no time constraint, provides a better presenter-audience interaction, and allows one to select and attend papers of interest. In Figure 2, we provide instructions, design, and layout in preparing a scientific poster. In the final presentation, Dr. Sahni provided the audience with step-by-step instructions on how to write and format posters for layout, content, font size, color, and graphics. Attendees were given specific guidance on the format of text on slides, the use of color, font type and size, and the use of illustrations and multimedia effects. Moreover, the importance of practical tips while delivering oral or poster

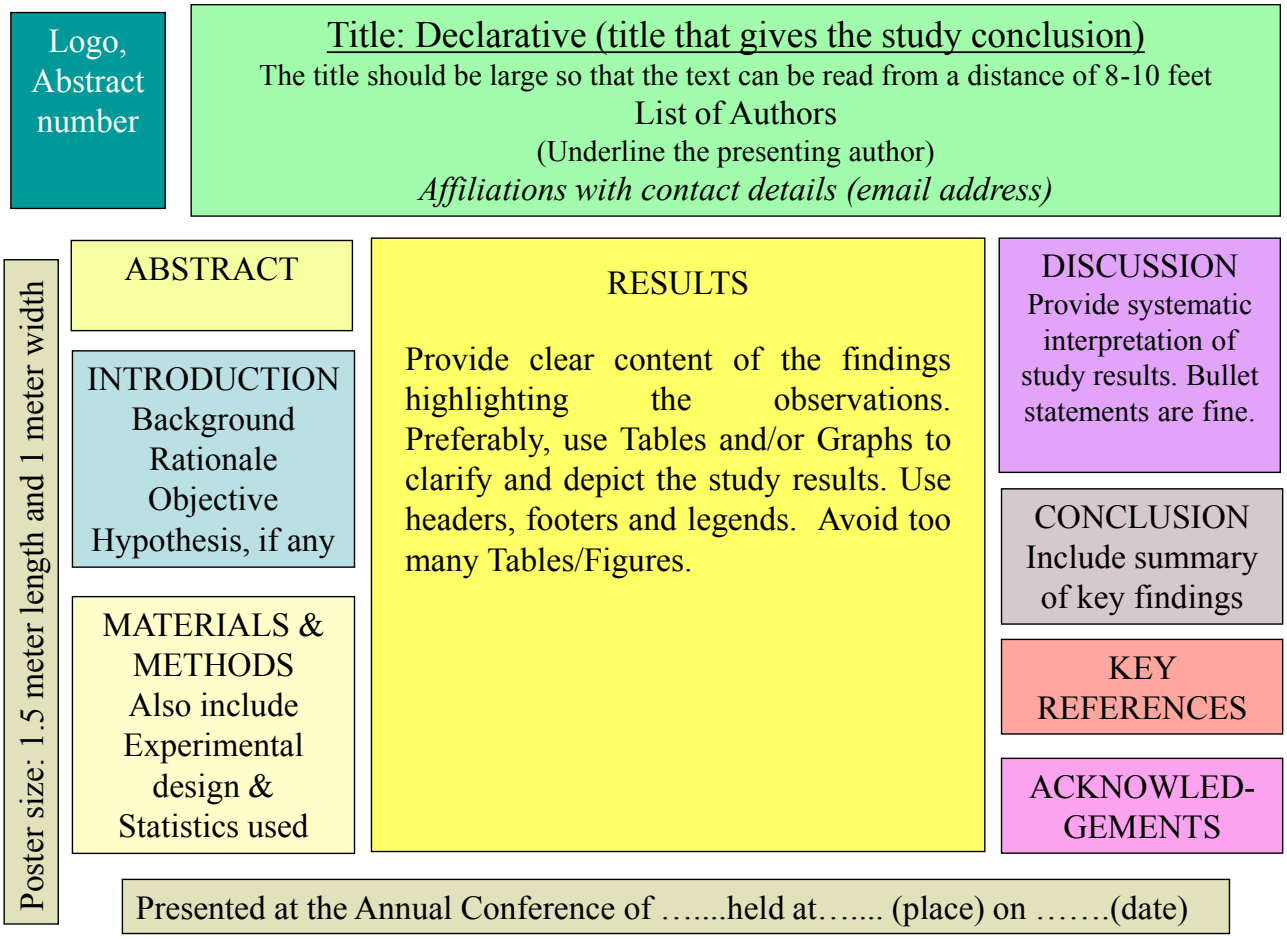

Figure 2: Guidelines and design to scientific poster presentation. The objective of scientific posters is to present laboratory work in scientific meetings. A poster is an excellent means of communicating scientific work, because it is a graphic representation of data. Posters should have focus points, and the intended message should be clearly conveyed through simple sections: Text, Tables, and Graphs. Posters should be clear, succinct, striking, and eye-catching. Colors should be used only where necessary. Use one font (Arial or Times New Roman) throughout. Fancy fonts should be avoided. All headings should have font size of 44, and be in bold capital letters. Size of Title may be a bit larger; subheading: Font size of 36, bold and caps. References and Acknowledgments, if any, should have font size of 24. Text should have font size between 24 and 30, in order to be legible from a distance of 3 to 6 feet. Do not use lengthy notes

presentation was provided to the audience, such as speak slowly and clearly, be informative, maintain eye contact, and listen to the questions from judges/audience carefully before coming up with an answer.

PANEL DISCUSSION: FEEDBACK AND COMMENTS BY PARTICIPANTS

After all the presentations were made, Dr. Jagadeesh began a panel discussion that included all speakers. The discussion was aimed at what we do currently and could do in the future with respect to 'developing a research question and then writing an effective thesis proposal/protocol followed by publication.' Dr. Jagadeesh asked the following questions to the panelists, while receiving questions/suggestions from the participants and panelists.

- Does a Post-Graduate or Ph.D. student receive adequate training, either through an institutional course, a workshop of the present nature, or from the guide?
- Are these Post-Graduates self-taught (like most of us who learnt the hard way)?
- How are these guides trained? How do we train them to become more efficient mentors?
- Does a Post-Graduate or Ph.D. student struggle to find a method (s) to carry out studies? To what extent do seniors/guides help a post graduate overcome technical difficulties? How difficult is it for a student to find chemicals, reagents, instruments, and technical help in conducting studies?
- Analyses of data and interpretation: Most students struggle without adequate guidance.
- Thesis and publications frequently feature inadequate/incorrect statistical analyses and representation of data in tables/graphs. The student, their guide, and the reviewers all share equal responsibility.
- Who initiates and drafts the research paper? The Post-Graduate or their guide?
- What kind of assistance does a Post-Graduate get from the guide in finalizing a paper for publication?
- Does the guide insist that each Post-Graduate thesis yield at least one paper, and each Ph.D. thesis more than two papers, plus a review article?

The panelists and audience expressed a variety of views, but were unable to arrive at a decisive conclusion.

WHAT HAVE THE PARTICIPANTS LEARNED?

At the end of this fast-moving two-day workshop, the participants had opportunities in learning the following topics:

- Sequential steps in developing a study protocol, from choosing a research topic to developing research questions and a hypothesis.
- Study protocols on different topics in their subject of specialization
- Searching and reviewing the literature
- Appropriate statistical analyses in biomedical research
- Scientific ethics in publication
- Writing and understanding the components of a research paper (IMRaD)
- Recognizing the value of good title, running title, abstract, key words, etc
- Importance of Tables and Figures in the Results section, and their importance in describing findings
- Evidence-based Discussion in a research paper
- Language and style in writing a paper and expert tips on getting it published
- Presentation of research findings at a conference (oral and poster).

Overall, the workshop was deemed very helpful to participants. The participants rated the quality of workshop from *"satisfied"* to *"very satisfied."* A significant number of participants were of the opinion that the time allotted for each presentation was short and thus, be extended from the present two days to four days with adequate time to ask questions. In addition, a 'hands-on' session should be introduced for writing a proposal and manuscript. A large number of attendees expressed their desire to attend a similar workshop, if conducted, in the near future.

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Disclaimer

The opinions expressed herein are those of Gowraganahalli Jagadeesh and do not necessarily reflect those of the US Food and Drug Administration

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