

The basic concepts of scientific research and scientific communication

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A report on the pre-conference workshop held in conjunction with the 63rd Annual Conference of the Indian Pharmaceutical Congress Association, 2011.

BACKGROUND

The 63rd Annual Conference of the Indian Pharmaceutical Congress (IPC) was held in Bengaluru, India, from 16 to 18 December 2011. It was hosted by the Karnataka state branch of the 'Indian Pharmaceutical Association'. The conference was preceded by a 2-day workshop, titled "The Basic Concepts of Scientific Research and Scientific Communication". This workshop, held on 14 and 15 December 2011 at Al-Ameen College of Pharmacy, Bengaluru, was organized under the aegis of the 63rd annual conference of the IPC. The workshop conveners were Dr. G. Jagadeesh of the US Food and Drug Administration (FDA), USA, and Dr. M. N. Inamdar of the Al-Ameen College of Pharmacy. The goals of the workshop were to teach 'research processes' and 'scientific writing'. The participants were novice researchers (M. Pharm and above), teaching faculty, and industry professionals working in R and D, QA/QC, and regulatory affairs.

The term 'research' is derived from the Middle French

'recherché', meaning 'to go about seeking'. Research is the original and intellectual investigation undertaken to discover, interpret, and revise the current scientific knowledge of a subject relevant to the needs of society. The workshop's objective was to provide guidance through topics such as thinking creatively and critically, generating research ideas, searching biomedical literature, reviewing literature, developing research protocols and proposals, analyzing data, and conducting research ethically and responsibly. The workshop also placed emphasis on scientific communication, because the writer narrates the story of the project, from initial thought process to final answer. The mastery of these skills is essential for an individual who embarks on a scientific and/or academic career. Research must demonstrate a potential for success and advancement of knowledge in the field of interest, thereby strengthening the future career prospects of a researcher.^[1-3] In light of these factors, the 2-day workshop included key lectures and interactive sessions for statistical analysis and writing an experimental protocol on different subjects of pharmaceutical sciences.

A GLIMPSE OF THE WORKSHOP

The workshop began with a short inauguration. In the welcome address, Dr. B. R. Jagashetty (Drugs Controller for the State of Karnataka, and Chairman of the local organizing committee (LOC) of the IPC) referred to the significance of the basic elements and logistics of performing research and writing a scientific paper. Dr. G. Jagadeesh (workshop

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convener) then presented the objectives and outline of the 2-day workshop. Day-1 was devoted to teaching the basic concepts of scientific research in 12 lectures with breakout sessions teaching: How to choose a research topic, how to describe the 'what' and 'why' of the study protocol, how to perform a literature search and review the literature, how to design an experimental study, and how to perform statistical data analyses. Day-2 consisted of seven lectures with breakout sessions teaching how to present one's work in a thesis or scientific paper for publication, how to submit a manuscript to a journal, and how to prepare and present posters and oral presentations at conferences. After all the presentations were made, the speakers and the audience participated in a panel discussion. The workshop faculty consisted of 13 distinguished speakers from India, New Zealand, and the USA. All the attendees (approximately 150 delegates) received a workshop manual, which included all of the speakers' presentations and additional supporting materials for statistical software.

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

Understanding an assortment of preliminary paths of scientific research is indispensable in making a flourishing scientific career. Day-1 of the workshop dealt with the 'basic concepts of research'.

Fundamentals in research process and cornerstones of a research project

Dr. G. Jagadeesh of the US FDA delivered the first lecture on 'Fundamentals in research process and cornerstones of a research project'. He described critical steps to create a successful startup in research. According to him, the fundamentals of a research protocol are: a researchable topic, research questions, objectives, hypothesis, rationale, background, and significance. He emphasized a mnemonic device to determine the objectives of a research project. It should be 'SMART'—Specific, Measurable, Achievable, Realistic, Time-framed. His discussion on 'creative thinking, critical thinking, and logic in research'^[4] was extremely instructive. Dr. Jagadeesh emphasized that completing any research project requires meticulous planning, experimental execution, compilation and publication of findings in the form of a research paper. Finally, he reminded the audience the words of M. Faraday: Work, Finish, and Publish.

Biomedical literature: Searching, reviewing, and reference management system

Searching, reviewing, and referencing are important components of the biomedical literature. The literature review is a building block of scientific research. The purpose of a review is to critically analyze a published body of knowledge in the relevant area of research; a purpose which requires a strong

literature searching skill. Speaking on this topic, Dr. B. Srikumar (Biocon Bristol-Myers Squibb R and D Center, Syngene International Ltd., Bengaluru) schematically explained the genesis of the scientific literature. He demonstrated PubMed search with examples and screenshots. Other search engines included in his presentation were International Pharmaceutical Abstracts, NLM Bookshelf, and Google Scholar. Furthermore, Dr. Srikumar described patent searching, using the example of the WIPO (*World Intellectual Property Organization*, <http://www.wipo.int>) search. Referencing and bibliography are essential parts of scientific writing. He described two major referencing systems, Vancouver and Harvard, and their variations. This was followed by a presentation by Dr. N. S. Chandrashekar (Thomson Reuters for India and ITC Research center, Bengaluru) who enlightened the audience on the bibliography management software program—EndNote®, used for creating and formatting bibliographies while writing a manuscript or thesis. He explained how a researcher can organize the references for citing in a manuscript or thesis using EndNote®, which also enables a researcher to collect references from a wide variety of online databases such as PubMed and Web of Knowledge, via direct export, online search, or importing text files. EndNote® assists in inserting references in the style of several hundred popular biomedical journals. Overall, the presentations from both resource persons were aimed at providing the audience with an insight into the literature review and reference management systems.

Writing experimental protocols

This workshop ambitiously planned to teach the principles and components in 'Writing a research protocol in various disciplines of Pharmaceutical Sciences'. This session comprised of five parallel breakout sessions, namely

- (i) Pharmaceutical Chemistry (presented by Dr. P. V. Bharatam, National Institute of Pharmaceutical Education and Research, Mohali, Punjab);
- (ii) Pharmacology (presented by Dr. G. Jagadeesh, US FDA, and Dr. P. Balakumar, Institute of Pharmacy, Rajendra Institute of Technology and Sciences, Sirsa, Haryana);
- (iii) Pharmaceutics (presented by Dr. H. N. Shiva Kumar, KLE University, Bengaluru);
- (iv) Pharmacy Practice (presented by Dr. Shobha Hiremath, Al-Ameen College of Pharmacy, Bengaluru); and
- (v) Pharmacognosy and Phytochemistry (presented by Dr. C. Veeresham, Kakatiya University, Warangal).

The speakers extensively covered the components of a typical research protocol in their respective subjects with examples. Once again, a need to write research questions, objectives, and hypotheses in a research protocol or proposal was discussed. Additionally, the speakers urged to include dependent and independent variables, and experimental designs in the protocol.

Basic biostatistics

The post-lunch portion of the workshop consisted of lectures and practice sessions in 'Basic biostatistics'. The participants were divided into two batches, with the theoretical aspects of basic biomedical statistics presented by Dr. R. Raveendran (Jawaharlal Institute of Postgraduate Medical Education and Research, Puducherry), and Dr. Avijit Hazra (Institute of Post Graduate Medical Education and Research, Kolkata). They discussed topics such as data types and characteristics, summary statistics, type I and II errors, significance testing, choosing a statistical test, sample size calculation, interpretation of 'p' value, and parametric and nonparametric statistical tests. After a coffee break, participants of both batches assembled for an hour-long practice session. A live demonstration was held on using various statistical analyses and software packages such as InStat and Power and Sample Size. The instructors also worked on sample problems given in the workshop manual.

Research and publication ethics

Ethics based on integrity and trust is a hallmark of a scientific publication. Although the majority of academic and industrial scientists publish their scientific findings, a considerable number of researchers are naïve with publication ethics. The first day of the workshop concluded with a presentation on research and publication ethics by Dr. M. K. Unnikrishnan (College of Pharmacy, Manipal University, Manipal). He spoke on publication ethics, including types of plagiarism, fabrication, falsification, gift authorship, ghostwriting, and sabotage. Additionally, Dr. Unnikrishnan pointed out the Ingelfinger rule^[5] which stipulates that a scientist must not publish the same original research in two different journals. He also advised the audience that the authorship entails not just credit, but also responsibility, for the scientific contents of a paper.

SCIENTIFIC COMMUNICATION: THE KEY TO SUCCESSFUL SELLING OF RESEARCH FINDINGS

Successful bench work should be translated in the form of a scientific publication in a peer-reviewed journal. Without publication, science is dead. Writing a research paper is as challenging as the research itself. The second day of the workshop dealt with 'scientific communication/writing'.

An overview of paper structure: How to write a good scientific paper

Dr. Amitabh Prakash (Adis, Wolters Kluwer, Auckland, New Zealand) spoke eloquently on 'Learning how to write a good scientific paper'. He started his presentation with a fact that original research publications normally follow an IMRaD structure (Introduction, Methods, Results, and Discussion). He suggested that the Title of a paper gives a chance to make

a good impression. The title might be either indicative (stating the purpose) or declarative (revealing the conclusion). He also stated 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. Dr. Prakash described the authorship criteria proposed by the International Committee of Medical Journal Editors (ICMJE) [Table 1] with examples of unethical authorship, and disclosures to be included in the 'Acknowledgement' section and the potential conflicts of interest of all authors. The final part of his presentation was allocated to thesis writing.

Presentations on 'Results' and 'Discussion' sections of a research paper were held in two parallel sessions. Dr. S. B. Deshpande (Institute of Medical Sciences, Banaras Hindu University, Varanasi) spoke on 'Effective Presentation of Results'. The key points conveyed during his presentation are summarized in Table 2.

The 'Discussion' features an interpretation of the results

Table 1: 'Authorship criteria' proposed by ICMJE

All named authors must meet all of the following criteria:

- (i) Substantial contributions to conception and design, or acquisition of data, or analysis and interpretation of data.
- (ii) Drafting the article or revising it critically for important intellectual content.
- (iii) Final approval of the version to be published.

Full description of requirements can be found at the ICMJE website: http://www.icmje.org/ethical_1author.html

Table 2: Understanding the 'Results' section

- (i) Results section comprises an important part of the paper that describes the observations of an investigation.
- (ii) This section may be subdivided into three segments: description of the observations in the **text** form, providing numerical data in a **Table**, and visualizing the observations in a **Figure** or Graph.
- (iii) All three segments from above are arranged in a sequential order to address the question hypothesized in the introductory section of a manuscript.
- (iv) Results are best presented as titled paragraphs.
- (v) The text of the results section should highlight the observations mentioning the significant differences between the groups while referring to a Table or Graph.
- (vi) The table has three parts—title, body (rows and columns of data) and footnote.
- (vii) It is advisable that a table should be readily understandable without referring to the text.
- (viii) The title of a table provides important findings of the experiment and that should be readily understandable.
- (ix) Column and row headings in a table should be clear with appropriate units. Footnotes may specify statistical significance, abbreviations used, etc.
- (x) A figure provides the evidence for the study, enhances the efficiency of presentation and/or emphasizes the observations made in a study.
- (xi) Avoid the use of illustrations that duplicate data presented in a Table. The legend should give adequate information for the Figure.

of a study. The Discussion section is the root of a research paper; it should be written carefully and based on results. Dr. Peush Sahni (All-India Institute of Medical Sciences, New Delhi) spoke on ‘Structuring the Discussion’ for a research paper. He said that a systematic interpretation of results within the available knowledge base of the study makes a good discussion. A discussion section should be confined to the most important points of the study topic, focusing on a key issue and providing linking sentences between paragraphs to ensure a smooth flow. Dr. Sahni suggested that a discussion section should not begin with history and should not extrapolate information. He lucidly explained that a discussion section must have a statement on major findings, strengths, and limitations on design, and that it must open the key findings for future research and new questions. It should wrap up with a summary of key findings (Conclusion). He used a published paper to illustrate the discussion points. In his second presentation titled ‘Writing an effective title and abstract’, Dr. Sahni described the important components of a good title and interacted with the audience on the pros and cons of a number of published titles. Dr. Sahni also went over the format of structured and unstructured abstracts.

Importance of clarity in writing, language, and style
The next lecture, by Dr. Prakash, focused on the language and style of a paper. He talked about sentence construction, language, grammar, and punctuation in scientific manuscripts, and proactively sought audience participation in correcting some prepared examples. Additionally, he suggested not using redundant and expendable words, jargon, and adjectives with incomparable words. Dr. Prakash also provided specific guidelines on the use of age referents in scientific writing. The final part of his presentation dealt with commonly misused words and phrases.

Working with journals
Once the manuscript is ready, it should be submitted to an appropriate journal. Dr. Prakash spoke on ‘Working with journals: Selecting a journal, cover letter, peer review process, and impact factor’. This lecture helped the audience learn the true value of a journal, understand the peer review process, and acquire tips for improving one’s manuscripts’ chances of acceptance. To this end, Dr. Prakash provided information on making an initial approach to the editorial office and drafting an appropriate cover letter to accompany the submission. In addition to the well-established Impact Factor™, other journal metrics such as the h index, SCImago Journal Rank (SJR), SCOPUS 2-year citation data, Eigenfactor™ score, and Article Influence™ score were discussed. After a brief overview of the ‘how’ and ‘why’, and the various types (double-blind, single-blind, open) of peer review processes, Dr. Prakash delved into the peer reviewer process and the roles of the reviewer, editor, and corresponding author in the publication of a scientific manuscript in a peer-reviewed

biomedical journal. Finally, Dr. Prakash discussed several real and potential drawbacks in the peer review process with suitable examples from recent history.

How to prepare a poster or do an oral presentation at conferences?
In the final lecture of the second day, Dr. Peush Sahni provided the audience with specific guidance on the ways and means of preparing and presenting posters and oral presentations at conferences. He gave step-by-step instructions on writing and formatting posters (e.g., layout, title, content, font size, graphics, objects, and working models). In addition, Dr. Sahni offered expert tips on the review and rehearsal of the presentation, printing and transport of the poster material, and conduct of the poster presenter at a conference. For an oral presentation, Dr. Sahni recommended the following structure: Title, introduction, body, conclusion, and message. Specific guidelines on the format of text on slides and the use of illustrations and multimedia effects were described with slides. Dr. Sahni also gave practical tips for delivering an effective presentation (e.g., speak slowly and clearly, be informative and interesting, appear involved and maintain eye contact, avoid unnecessary detail). He also suggested that presenters should visit the venue and inspect the audio-visual facilities before the presentation, and presenters should be suitably dressed, ideally begin, and end the presentation in a lighted room.

PANEL DISCUSSION, FEEDBACK, AND COMMENTS BY PARTICIPANTS

The panel discussion, moderated by Dr. Jagadeesh, began after the conclusion of all presentations and included all speakers who were able to attend. The subject of discussion was essentially the ‘research process and scientific publication’ [Table 3].

Dr. Jagadeesh asked the questions, given in Table 4, to the

Table 3: Topics discussed
(i) Critical steps to create a successful Research: Guide (Mentor), Environment (Infrastructure), and Research protocol.
(ii) Is mentorship provided with high standards and great examples? Does a guide create a student with silver scientific spoon? Alternatively, does a guide leave everything to a student to work out? (That means the guide just signs off the thesis).
(iii) Discuss communication/interface between a research student and a guide in developing a project. Extent of contribution from a guide—from choosing/suggesting a topic or giving a “study outline” to finalizing a protocol.
(iv) The contribution by a research student toward literature search, review of literature, developing an idea, and writing a protocol.
(v) Writing a protocol, who does what?
(vi) Preparation of Manuscript for Publication. Who initiates and writes the first draft of the manuscript? What is the extent of contribution by a guide and a student in publication of thesis work?

Table 4: Questions to the speakers

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| (i) How much training does a PG student need in order to develop and write a research proposal or protocol? |
| (ii) What is the role of a guide in imparting research concepts to a PG student? |
| (iii) Should there be courses like, "Research methods, Scientific writing, Ethics" (non-binding), in all University departments/ colleges? |
| (iv) What are your thoughts on scientific writing, such as manuscript preparation (contributors), journal selection (peer-reviewed journal, impact factor, etc.) and publication of a research or review paper? |

panelists (speakers), in sequence, with time for receiving questions/suggestions from the participants and panelists.

This session lasted over 1 hour. All participants appeared satisfied with the deliberations made at the workshop and shared their personal experiences on their research projects and difficulties they encountered. The speakers advised the delegates that a casual approach in preparing a manuscript could reflect a casual approach in the experimental work, and that impression must be avoided. It was evident from the mood that the audience had a good grasp of scientific issues discussed in each of the presentations, as they actively contributed to the panel discussion.

WHAT HAVE THE PARTICIPANTS LEARNED?

At the end of this fast-moving 2-day workshop, the participants had achieved a general understanding of the topics broadly related to the 'concepts of scientific research and scientific communication'.

Based on the feedback received, the outcomes of the pre-conference workshop were exceptionally helpful to participants hailing from different parts of the country. The

evaluation forms suggested "very satisfied to satisfied" about the way the workshop was organized and executed. A majority of the participants expressed strong interest in attending a similar workshop, if offered in the future.

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