Research-oriented medical education for graduate medical students

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ABSTRACT

Background. In most parts of the world, medical education is predominantly geared to create service personnel for medical and health services. Training in research is ignored, which is a major handicap for students who are motivated to do research. The main objective of this study was to develop, for such students, a cost-effective 'in-study' research training module that could be adopted even by medical colleges, which have a modest research infrastructure, in different regions of India.

Methods. Short-duration workshops on the clinical and laboratory medicine research methods including clinical protocol development were held in different parts of India to facilitate participation of students from various regions. Nine workshops covering the entire country were conducted between July 2010 and December 2011. Participation was voluntary and by invitation only to the recipients of the Indian Council of Medical Research–Short-term Studentship programme (ICMR-STS), which was taken as an index of students' research motivation. Faculty was drawn from the medical institutions in the region. All expenses on students, including their travel, and that of the faculty were borne by the academy. Impact of the workshop was judged by the performance of the participants in pre- and post-workshop tests with multiple-choice questions (MCQs) containing the same set of questions. There was no negative marking. Anonymous student feedback was obtained using a questionnaire.

Results. Forty-one per cent of the 1009 invited students attended the workshops. These workshops had a positive impact on the participants. Only 20% students could pass and just 2.3% scored >80% marks in the pre-workshop test. There was a three-fold increase in the pass percentage and over 20% of the participants scored >80% marks (A grade) in the post-workshop test. The difference between the pre- and post-workshop performance was statistically significant at all the centres. In the feedback from participants, the workshop received an average rating of 8.1 on a scale of 1 to 10.

Conclusion. This cost-effective, 'in-study' module of short-duration 'mobile' workshops can be used to educate graduate medical students in basic research procedures employed in clinical and laboratory medicine research. The module is suitable for resource-strapped developing nations.

Natl Med J India 2013;26:169–73

INTRODUCTION

A core recommendation of the 100-year-old Abraham Flexner report, which changed American medical education, was 'scientific inquiry and discovery, not past traditions and practice, should point the way to the future in both medicine and medical education' putting research at the centre of medical education. These recommendations should be relevant to both the developed and developing world. However, the latter lack funds even for routine teaching and service. Therefore, training is predominantly service-oriented; research gets the lowest priority as is evident by the dismal publication record.[1] Developing countries are going through an epidemiological transition and cannot ignore the impact of non-communicable, chronic lifestyle disorders.[2] Despite a resource crunch, they need to promote research to develop their own cost-effective strategies for the changing health scenario. Cost-effective training programmes in research procedures would be a boon. The availability of trained persons would also facilitate international collaboration.[3]

'Credit' courses in research procedures in health and biomedicine are regularly conducted in all major universities in western countries. Online courses are also becoming increasingly popular.[4] A large number of medical schools run even combined MD–PhD programmes. While there are no regular healthcare research training programmes in India, leading institutions do conduct short-term workshops especially for postgraduates and research workers on specific topics such as clinical trials, biostatistics, medical ethics, medical writing, communications skills, etc. To the best of my knowledge no such programme exists for undergraduate/graduate medical students.

I organized two national undergraduate medical students' research conferences under the banner of the Moving Academy of Medicine and Biomedicine in 2006 and 2008 in Pune.[5] Although the quality of presentations was good, these could have been improved vastly if the students were trained in research methodology. The heavy medical curriculum does not have any space for training in research methods. Also, only a small proportion of medical students are motivated to do research.

In this communication, I describe a short-duration, 'in-study', economic module of 'mobile' workshops in clinical and laboratory medicine research methods that could be conducted in medical colleges with even a modest research infrastructure.

METHODS

Participants and resource faculty

For the past several years, the Indian Council of Medical Research (ICMR) offers short-term studentships (STS) to graduate medical students to undertake 'in-study' research projects for 2 months during the summer break.[6] All students are eligible to apply. However, a very small proportion avails the opportunity. Selection in the STS programme was therefore used as the yardstick of students' motivation to do research. Participation in the workshop was voluntary and by invitation to recipients of the STS programme during that year. A total of 1009 students were sent invitations but only 413 students (40.9%) attended the workshop. The main reasons for not attending the workshop were dates clashing with examination schedules and inability to get institutional clearance.

The programme was launched in July 2010 and till December 2011, a total of 9 workshops were conducted in different regions of India—North (2 in Delhi and 1 in Patiala), West (2 in Pune and 1 in Mumbai), South (Chennai), East (Bhubaneswar) and Southwest (Manipal). The data for the Delhi and Pune workshops (one each in 2010 and 2011) were pooled for the purposes of analysis. In Bhubaneswar, where only 16 STS students had

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applied, the principals/deans of the colleges in the region were requested to nominate students who would be interested in attending such workshops. Nine non-STS students from neighbouring colleges participated in the workshop. Pre- as well as post-workshop scores of the STS and non-STS students were similar. The data were therefore pooled.

Students were provided travel reimbursement, local hospitality and received free of cost reading material consisting of handouts of workshop lectures. To make the programme cost-effective, special efforts were made to choose faculty from medical colleges/research institutes in the region. To facilitate better interaction, the number of participants in each workshop was restricted to 60.

Workshop contents

Each workshop was conducted over 3 days. The contents were broadly categorized into—

1. A core component consisting of (common to all workshops)
   (a) Lectures on clinical research methods,
   (b) Group activities (conducted only in the last five workshops), and
   (c) Laboratory medicine demonstrations.
   The first two days were devoted to clinical and epidemiological research. Laboratory medicine demonstrations were held on the last day.
2. Special lectures were held on topics in communicable and non-communicable disorders. Some of these lectures were trends in cancer research, human immunodeficiency virus (HIV)–tuberculosis and swine flu pandemic.
3. The participants were also exposed to a bird's-eye view of the research spectrum at the host institute. Demonstrations were held using locally available modern gadgets.

There was considerable variation in the contents of the last two activities as these were dependent entirely on the locally available gadgets and expertise. However, pre- and post-workshop assessment was restricted to only the core course.

Lectures

Each lecture was for a duration of 40–50 minutes including discussions. Lectures on biostatistics were provided more time and all sessions were kept interactive. The following areas were covered:

1. Types of research
2. Study designs
3. Research ethics
4. Biostatistics
5. Commonly used computer software for statistical packages such as *statistical package for the social sciences* (SPSS).
6. Good clinical practice (GCP)
7. Good clinical laboratory practice (GCLP)
8. Development of a clinical protocol
9. Epidemiological research
10. Drug development including clinical phases of drug/vaccine trials
11. Formulation of a research question
12. Communication skills
13. Writing a research proposal for funding. The ICMR format was used as an example.

Group activities

Participants were divided into groups of 10–12 students and given topics to design clinical protocols which were discussed by experts during a special session. Some of the topics assigned to the students were:

1. Assess relative bioavailability of iron from a powdered supplement, marketed by a pharmaceutical company, and the traditional iron tablet.
2. Compare the immune responses and safety of a licensed and a new candidate influenza vaccine in a specific age group.
3. Investigate relative incidence of acute pancreatitis associated with exenatide and other oral hypoglycaemic agents.
4. Assess the prevalence of hypertension in adults of a tribal population.

Laboratory medicine

The last day started with a lecture on the basic principles of commonly used molecular medicine technologies. The students were then divided into small groups and demonstrated commonly used techniques of molecular medicine including:

1. Isolation and purification of tissue proteins
2. Protein electrophoresis (polyacrylamidegel electrophoresis [PAGE] and sodium dudecyl sulphate-PAGE [SDS–PAGE])
3. DNA extraction
4. Agarose electrophoresis
5. Polymerase chain reaction (PCR) and reverse transcriptase-PCR (CRT-PCR)
6. Restriction enzyme digestion
7. Enzyme-linked immunosorbent assay (ELISA)
8. Immunoperoxidase
9. Cytogenetics
10. Demonstration of special techniques (DNA microarray, *in situ* hybridization, etc.) and equipment (fluorescence-activated cell sorting [FACS], confocal microscopy, electron microscope, etc.) available at the host institute.

Pre- and post-workshop tests

Participants were informed about the pre- and post-workshop assessments and their purpose just before the start of the workshop. Single answer multiple-choice questions (MCQs) related to only the core course were administered to the students. The same questionnaire was used in all the workshops. The pre-workshop assessment had 40 questions covering all the topics mentioned in the core component of the course. The post-workshop assessment had all the pre-workshop questions and 30 additional questions. For assessing the impact of the workshop on a student, only questions common to both pre- and post-workshop tests were used.

Of the 413 participants, who attended the workshops, 341 (82.5%) took both the pre- and post-workshop assessments. The reason for their absence at one of the assessments was either late arrival or early departure due to logistic reasons. Their number varied from centre to centre, and the faculty differed from place to place. Except for two centres (Manipal and Chennai) the data were not normally distributed. The pooled data were also not normally distributed. Therefore, the results of each centre were analysed individually.

Parametric or non-parametric data were analysed using paired, two-tailed, Student *t*-test and Wilcoxon signed-ranks test, respectively. A p value <0.05 was considered significant.

There was no negative marking and the minimum pass percentage was 70%. Depending on the students' scores, they were arbitrarily placed in different categories. Students scoring 70%–79%, 80%–89% and >90% marks were categorized as B (satisfactory or pass), A (good) and A+ (very good) grades,

respectively. The grading was used to assess the pre- and post-workshop performance.

Feedback from participants was obtained using a simplified semi-quantitative anonymous questionnaire in which they were asked to comment on whether the workshop was beneficial to them and if so whether they would like to have translational science workshops on specific topics. They were also asked to comment on the contents of the course, quality of lectures and the reading material provided to them. Comments were obtained on the duration of the workshop under three broad scales—optimal, too long or too short. Finally to get some idea of their overall perception, participants were asked to rate the workshop quantitatively on an ascending scale of 1 to 10.

RESULTS

The baseline average scores were similar at all the centres except Chennai (51.4%), and varied between 57.7% and 62.4%. The reasons for a lower score (51.4%) in Chennai are not clear. The average post-workshop scores were higher than the pre-workshop scores at each centre and the improvement varied from 9.7% to 13%. The differences between the pre- and post-workshop scores were significant at all the centres including the overall data (Tables I and II, Fig. 1). The average pre- and post-workshop scores in the pooled data were 58.7% and 70.8%, respectively. The same pattern was seen at all levels in all the centres and scores improved at all levels in the latter. Whereas only 18.2% of the participants scored above 70% marks (pass marks) in the pre-workshop assessment, this increased 3.5-fold (64.6%) in the post-workshop assessment. The number of students who obtained A grade (>80% marks) was 2.5% and 20.3% in the pre- and post-workshop assessments, respectively. Thus, there was a positive impact of the workshop.

Qualitative assessment

All participants felt that they benefited from the workshop. They were keen to attend additional translational research workshops on emerging topics such as oncology, human genetics, immunology, organ transplantation, emergency medicine, molecular medicine and also organ-specific topics. A large majority (80%) of students was happy with the contents and quality of lectures. A few wanted more time for statistics and laboratory medicine. Students appreciated the interactive nature of the workshops although about 5% felt that the workshop could have been more interactive. About 20% students felt that the reading material provided needed to be improved. In general, participants felt that 'soft copies' of the lectures should have been made available before commencement of the workshop.

Most participants felt that the duration of the workshop was optimal (83.2%), 10.5% felt that it was short, while 5.1% thought that it was long and 5.2% offered no comments. Their overall rating was 8.1 on a scale of 1 to 10 (Fig. 2).

DISCUSSION

This study describes a module of a short duration, 'mobile' in-study workshops for imparting training to graduate medical students in clinical and laboratory medicine research methods. Participation was by invitation to the ICMR-STS students but was voluntary with no selection. Thus, the programme was focused at students who had previously shown some inclination towards research. Further, the workshops were held in different medical institutes so as to provide training opportunities to students from different regions of India. The impact of the workshops was evident from the participants' comparative performance at the pre- and post-workshop assessments at all the centres. Also the participants' feedback gave a high rating to the workshop.

Despite changes in medical education there is a declining interest in research. In the USA, only 4% of MDs (15 377 of 376 512) reported research as their priority in 1980. Seventeen years later, this was only 2.3% (14 434 of 620 472).[7,8] Several short- and long-term programmes have been launched by the National Institutes of Health, USA to promote research among graduate students in medical schools.[9,10] With the same objective, the ICMR launched the STS programme in 1979.[6] National and international research conferences also provide students a forum to present their research and interact with fellow students.[5,11,12]

Yet another approach to promoting research among medical students would be to make it a mandatory part of medical education. However, there are conflicting data on this approach.[13–15] In India, where writing a thesis is a mandatory requirement for postgraduate students in the health sciences (MD and MS), the quality of theses is poor[16] and most do not result in publications. Thus, making research compulsory may not result in high dividends. This may be because only a small proportion of the student population is actually interested in research. In two studies from India, the proportion of students motivated to do research vary between 3.5% and 8.3%.[17,18] The ICMR-STS programme is open to all. Yet

TABLE I. Pre- and post-workshop assessment scores at different centres

Score	Delhi* (*n*=74)		Pune* (*n*=101)		Mumbai* (*n*=31)		Manipal* (*n*=26)		Bhubaneswar* (*n*=25)		Chennai† (*n*=49)		Patiala† (*n*=35)		Total* (*n*=341)	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Mean (%)	58.50	72.40	60.80	71.30	61.80	71.50	62.40	74.60	58.96	72.8	51.40	64.00	57.70	71.40	58.70	70.80
SD	13.58	10.90	11.93	9.76	8.46	7.60	9.14	8.64	13.32	7.88	13.10	12.30	16.40	12.57	13.00	10.69
Median	60	74	60	74	62	72	64	74	62	74	50	66	64	71	60	72
Range	24–85	38–90	26–82	28–92	42–76	44–86	40–78	60–90	22–78	50–82	18–72	34–86	12–80	31–83	12–88	28–92
Percentiles																
25th	50	65.0	56	68	58	68	56	67.5	51	68	41	55	46	63	50	66
50th	60	74.0	62	72	64	72	64	74.0	62	74	50	66	64	71	60	72
75th	68	80.5	70	78	68	76	70	82.0	67	78	62	74	70	79	68	78
Outliers (only LIF)‡	0	2	5	4	1	1	0	0	0	0	0	0	0	2	3	13
p value	0.01		0.01		0.01		0.01		0.01		0.01		0.01		0.01	

SD standard deviation LIF lower inner fence * Data not normally distributed: Wilcoxon signed-ranks test used †Data normally distributed: paired samples Student *t*-test used ‡ There were no outliers in the UIF (upper inner fence)

TABLE II. Percentage distribution of the participants according to marks scored in various categories (first column) at different centres in pre- and post-workshop MCQ tests

Score out of 100	Delhi* (*n*=74)		Pune* (*n*=101)		Mumbai* (*n*=31)		Manipal* (*n*=26)		Bhubaneswar* (*n*=25)		Chennai† (*n*=49)		Patiala† (*n*=35)		Total* (*n*=341)	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
<40	10.8	1.4	6.9	1	–	–	–	–	8	–	22.4	2	14.3	2.9	9.7	1.2
40–49	10.8	1.4	6.9	1.9	12.9	3.2	3.8	–	12	–	20.4	14.3	17.1	2.9	11.4	3.8
50–59	25.7	6.7	23.8	5.9	12.9	3.2	26.9	–	24	4	18.4	18.4	14.3	5.7	21.4	7
60–69	31	27	46.5	21.8	54.8	19.4	42.4	26.9	40	24	34.7	26.5	22.8	20	39.3	23.4
70–79	17.6	33.8	11.9	52.5	19.4	64.5	26.9	42.3	16	52	4.1	32.7	28.6	37.1	15.9	44.3
80–89	4.1	28.3	4	15.9	–	9.7	–	23.1	–	20	–	6.1	2.9	31.4	2.3	19.1
>90	–	1.4	–	1	–	–	–	7.7	–	–	–	–	–	–	–	1.2
p value	0.01		0.01		0.01		0.01		0.01		0.01		0.01		0.01	

* Data not normally distributed: Wilcoxon signed-ranks test used †Data normally distributed: paired samples Student *t*-test used MCQ multiple-choice question

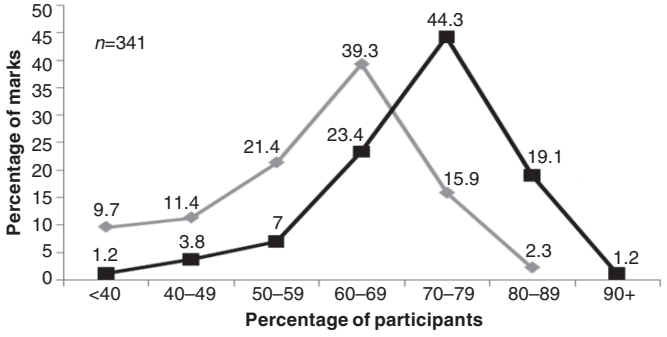

FIG 1. Diagrammatic representation of pre- (grey) and post-workshop (black) assessment. The post-workshop graph shows a shift to the right indicating improved performance at all levels. Numbers above each point are mean scores for that category (*n*=341).

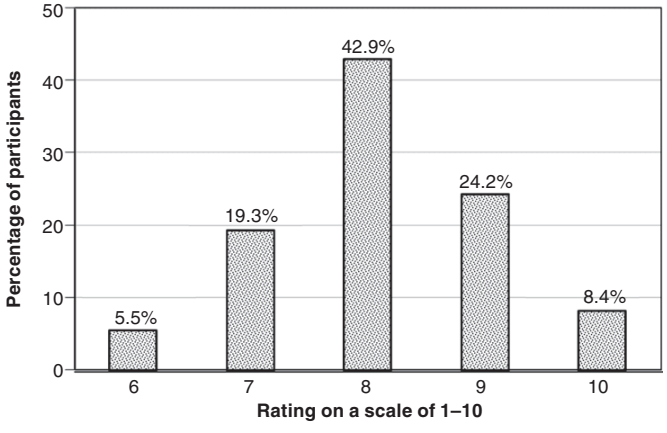

FIG 2. Feedback of participants on a scale of 1–10. Numbers on the top of each bar indicate the percentage of participants that gave the rating.

in 2011, about 4000 applications were received from 300 medical colleges[19] with a cumulative graduate student population of over 100 000. In other words, only 4% of students are interested in research.[20] Focusing on the small number of students with an aptitude for research is likely to pay higher dividends; an approach adopted in this study.

A combined MD–PhD programme is likely to attract only highly motivated students. Unfortunately, barring a few medical colleges in India, most lack both the physical infrastructure and human resources to conduct such a programme. Also, despite incentives such programmes face several challenges even in advanced and economically sound nations. Not only it takes more time to complete the MD–PhD programme, but even after completion of the course students tend to revert to practice, once the obligations for entering the course are over.[21] In India, where promotions are mostly by seniority in service and lateral entry an exception, additional years spent in obtaining an MD (MBBS)–PhD would be a lifelong handicap for students.

A better option for us would be to conduct 'in-study/in-service' research training programmes for graduates, postgraduates and faculty. Obviously, the contents of such courses will not match the depth and spectrum of an MD–PhD programme. Controlled studies show that courses, which do not involve laboratory medicine, conducted 'online' or through video conferencing, are as effective as on-site courses.[22,23] This should reduce the cost substantially.

Doubts have been raised about the utility of short-duration workshops. The results of this study, both the pre- and post-workshop assessment as well as feedback from participants indicate that this approach has been effective. In my opinion the main reason has been restricting the workshop to students with an interest in or with an aptitude for research. The workshops would only 'prime' motivated students to explore options at an early stage of their career. Such workshops would enable them to participate later in advanced research workshops on specific topics.

Cost is an important consideration for any new initiative especially in resource-poor settings. While I have not provided the detailed expenditure of the workshop, I have worked out the cost to be about ₹4000 (US$ 70) per participant.

The five important components of the module are (i) its short duration and 'in-study' nature places the least additional burden on already overcrowded medical curriculum, (ii) it is cost-effective, (iii) it is 'mobile' and can be taken to any part of the country, (iv) resources were optimally utilized as the focus was on motivated graduate students, and (v) participation was voluntary.

With a progressive decline of the medical fraternity's engagement with research,[7,8] biomedical and clinical research is increasingly being done by basic scientists for whom this short-term programme will be worthwhile. They would benefit by exposure to clinical and laboratory medicine procedures during their training. The same would be true for those working in inter-phase fields such as biomedical engineering.

The study has limitations including: (i) participants were not a strictly homogeneous group as they were from different levels of

the medical course; (ii) there was some selection bias as the workshop was focused only on STS recipients; (iii) the same faculty was not used at all centres; (iv) the workshop was on-site. Similar workshops conducted through video conferencing or online need to be compared in well-designed, randomized studies using the same faculty which, for the reasons mentioned above, was one of the intentional variables in this communication; and (v) while the short-term results were encouraging, these students need to be followed over a longer period to assess the long-term effect of this study.

All developing nations are perpetually short of resources, both human and financial, and spend their meagre resources on routine teaching and service; research is considered to be a 'luxury'. Therefore, as an alternative they often participate in international collaborative research programmes. It has been increasingly realized that the days of 'parachute' research, where experts just come and go and developing nations act as 'material suppliers' are numbered.[3] Creation of basic infrastructure and research training for local staff especially related to the concerned project in developing nations is now promoted by many international programmes.[24] However, these are short-term solutions. In the long run, every nation must develop local solutions for our health problems. It is necessary that we nurture talented students through cost-effective research training programmes. To start with, the module of this workshop should be suitable for developing nations.

ACKNOWLEDGEMENTS

Workshops were conducted at different locations with the help of the following host institutes which also supported the implementation. I am deeply grateful to the following organizations and individuals.

1. National Institute of Pathology, New Delhi, India (Dr Sunita Saxena, Director)
2. University College of Medical Sciences, Delhi, India (Dr O.P. Kalra, Principal)
3. National Institute of Virology, Pune, India (Dr A.C. Misra, Director)
4. National Institute of Reproductive Health, Mumbai, India (Dr S.D. Kolkute, Director)
5. Manipal Centre for Clinical Research, Manipal University, Manipal, India (Dr K.L. Bairy, Director)
6. Government Medical College, Patiala, India (Dr K.D. Singh, Principal)
7. Postgraduate Institute of Medical Education and Research, Chandigarh, India (Dr Kusum Joshi, Head, Department of Histopathology)
8. National Institute of AIDS Research, Pune, India (Dr R.S. Paranjpe, Director)
9. National Institute of Epidemiology, Chennai, India (Dr Sanjay Mehendale, Director)

The Indian Council of Medical Research, New Delhi, India funded this activity.

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