

# Medical Education

## Integrating medical biostatistics into postgraduate medical curriculum

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### ABSTRACT

**Background.** Knowledge of biostatistics is important for a health professional to understand research methods, analyse new information presented in scientific journals and to assess its relevance for their clinical practice.

**Methods.** We discuss the implementation of biostatistics in medical curricula, give perspectives on medical education in India, and narrate our own experience of integration of biostatistics into the medical curriculum.

**Results.** Biostatistics is still not a part of all postgraduate curricula in spite of its growing importance for all medical practitioners in the 21st century.

**Conclusion.** The need for a reliable tool in research and evidence-based medicine is recognized in most postgraduate medical curricula in developed countries to improve teaching–learning outcomes.

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### INTRODUCTION

The medical practitioner in the 21st century needs the ability to evaluate new information and technologies. A good understanding and application of epidemiology and biostatistics can improve medical and clinical decision-making, medical practice and medical research.<sup>1</sup>

Knowledge of biostatistics, as a tool for all biomedical research and analytical reasoning,<sup>2</sup> is important for health professionals to understand scientific research, analyse new information presented in scientific journals and to translate scientific knowledge to their clinical practice.

Thus, inclusion of biostatistics in the medical curriculum is important.<sup>1</sup> While biostatistics is commonly included in the curricula of undergraduate medical schools all over the world, it remains largely absent from the postgraduate medical education and residency curricula in India.

### TREND OF INCLUDING BIOSTATISTICS IN MEDICAL CURRICULA

#### Factors

Many factors determine the trend to introduce biostatistics in the postgraduate medical curriculum. One of the major reasons for this trend is the increased need for public health information

about new diseases and health prevention methods. Public awareness of health maintenance is a major direction in health research and hence the need for instruction in biostatistics too has increased.<sup>3</sup>

A new dimension in teaching–learning methods came when computers entered the field of medical education. The new knowledge enhanced the importance of uniform instruction and education, which allowed exchange of relevant information as well as development of new educational programmes and standardized curricula, such as across the European Union following the European credit accumulation and transfer system (ECTS).<sup>4</sup>

### NATURE AND HISTORY OF THE TREND

#### Indian trend

Postgraduate medical education is influenced by previously acquired knowledge and skills in undergraduate biostatistics training. In India, the status of biostatistics or medical statistics training was reviewed in 2012 by a situational analysis study.<sup>5</sup> It was inferred that few institutes were contributing positively towards education in biostatistics. In undergraduate curricula in most medical schools across India, students are exposed to formal training in biostatistics<sup>6</sup> at the basic level, but not integrated with medical topics, and neither in problem-based learning (PBL) nor in problem-solving.<sup>7</sup>

Statistics has a long tradition in India. In 1931, when the Indian Statistical Institute (ISI) was established, medical education was mostly according to the UK model and in most medical schools in India statistics was introduced not much later than that in the UK.<sup>5</sup> All over India the traditional medical curricula is used for undergraduate and postgraduate students. The postgraduate student's academic journey starts as fresh medical graduates (MBBS). The lack of faculty in departments of biostatistics in medical colleges and academic institutions makes it difficult to provide biostatistical training during undergraduation.

As they have limited exposure to biostatistics during their undergraduate education, it becomes difficult for postgraduate medical students to write their thesis with ease and confidence.<sup>6</sup> If taught again as a separate topic, deprived of clinical implementation, it will be hard for students to value the importance of biostatistics and to acquire the needed knowledge and skills.

The terminal competencies for a medical practitioner are largely based on problem-solving.<sup>7</sup> Why not teach students the way they can learn and apply better what they have been taught? During postgraduate medical education this can be improved.

#### Other countries

Many developed countries recognized the need for instruction in biostatistics in the postgraduate curriculum early after its

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implementation at the undergraduate level, as this training is necessary for decision-making. At the time of publication of the American Statistical Association Report in 1975 all major schools of medicine across the USA and Canada had formal instruction in biostatistics for doctors but the level and the number of active classes remained different. Till the 1980s, only one half of those schools had developed a distinct course of biostatistics as a subject of 'minor importance'.<sup>8</sup>

Medical education in the USA is largely based on a new 4-year curriculum divided in preclinical and clinical parts. At one of the most prestigious institutions, Harvard Medical School, the curriculum is revised regularly and adapted to new professional requirement of terminal competencies. The ultimate curriculum revision in 2012 has a major goal: 'to develop a new model of clinical education that is based on the educational and developmental needs of the student and that offers longitudinal continuity of patient experience, cross-disciplinary curricular content, faculty mentoring, and student evaluation'.<sup>9</sup> Teaching biostatistics is an integral part of all three phases of their curriculum: Fundamentals of Medicine; Principal Clinical Experience and Advanced Experiences in Clinical Medicine and Science as a part of Evidence-Based Medicine and Medical Decision Making with an aim to provide in-depth knowledge.

In School of Medicine, University of Belgrade, biostatistics was implemented along with SPSS computer laboratory in postgraduate education as a major core subject for all masters' and specialization programmes in 1980 with a duration of one semester, but doctors prefer to consult professional statisticians.

The Postgraduate Medical Institute in Lahore, Pakistan implemented the formal teaching of biostatistics in 2008. However, a proportion of doctors use computer packages without background knowledge of biostatistics leading to misinterpretation of clinical observations.<sup>10</sup>

In Taiwan, training of biostatistics in the postgraduate curriculum resulted in improvement in understanding results of studies published in medical research papers.<sup>11</sup>

However, the implementation of a new subject has to be at the appropriate time. The experience in Barcelona showed that doctors who started training in evidence-based practice (EBP) without previous knowledge in biostatistics had difficulty in understanding the new discipline.<sup>12</sup>

In China, biostatistics is a separate subject for postgraduate students for over 30 years and the main training in biostatistics is at the postgraduate level.<sup>13</sup> Leading schools of medicine in the UK adopted PBL, but biostatistics and research methods were not included. They soon adopted the Australian experience. Biostatistics was integrated in clinical and basic sciences teaching, and different tutors taught their primary subjects emphasizing medical hypothesis, standardization in anthropological measurement, normal distribution and other topics. Despite several difficulties in implementing an integrated approach, it has advantages.<sup>14</sup>

### *Advantages*

Implementation of biostatistics as an independent subject for postgraduate students has many advantages. From the beginning, the organization 'Teachers of Statistics' in the health sciences defined the major task of teaching biostatistics as 'relevant instructions for medical students and medical practitioners in order to improve the quality of delivered health service'. It remains the major advantage of implementation of formal postgraduate training. Proper understanding of the

literature and papers published in medical journals is difficult without a background in biostatistics as well as in medicine. We did not come across any disadvantages of implementing biostatistics for postgraduates in the literature.

### GUIDELINES FOR IMPLEMENTATION

As the postgraduate curriculum is an upgrade of the undergraduate curriculum, schools of medicine must promote teaching in research methodology and encourage involvement of undergraduate students in all activities of the school of medicine.<sup>3</sup> Biostatistics must be taught at the postgraduate level at the right time for it to be of maximal benefit, i.e. after introducing research components and acquiring knowledge in the field of study, and basic components of evidence-based medicine, with relevant content and tutors.<sup>12</sup>

The teaching of medical statistics in a developing nation like India has many challenges: teaching of biostatistics is commonly by the department of community medicine. However, in developed countries, it is under separate departments of biostatistics and epidemiology. The importance of biostatistics in research and its application needs to be emphasized and improved.<sup>15</sup>

Here are a few examples of integrating biostatistics into medical subjects. The first step is to adopt the team teaching approach in formal postgraduate teaching. Postgraduate teaching has to take place in the hospital or laboratory setting according to specialization. With case-based learning, biostatistics can be taught as part of evidence-based medicine.<sup>16</sup>

Even if postgraduate students have not been taught as undergraduates using an integrated approach, it can be started at the postgraduate level integrating biostatistics with clinical teaching. An example of horizontal integration in internal medicine could be to start the teaching-learning process in the cardiology department with a diagnosis and management of a specific heart problem. Learning the normal range of medical parameters is the best moment to revise measures of central tendency and dispersion (which are taught at the undergraduate level) through a clinical example and immediate application. When facing the problem of interpretation of patients' values according to reference values of physiological parameters, students can be taught to apply T-test for comparison; Mann-Whitney U-test as a useful tool to help solve a clinical problem can also be illustrated.

Another example of an application is to reach a specific diagnosis by introducing pre-test probability by calculating the proportion of patients with and without the disorder, before a diagnostic test result is known.<sup>16</sup>

The next step in the clinical environment is diagnosis along with solving a problem. Students can be taught the principles of medical decision-making and type I and II errors. The best or most appropriate diagnostic method is always an important part of making the diagnosis and is an appropriate time to teach methods to evaluate the accuracy of a diagnostic test (specificity, sensitivity, predictive values, likelihood ratios and rates, as well as Bayes theorem). Students will thus learn how to select an appropriate diagnostic test and to interpret its results.

An example in surgery: Number needed to treat or harm (NNTs), converting ORs (odds ratios) to NNTs, can be used to choose whether the drug or surgical therapy reduces the risk of the bad outcome from randomized control trials (RCTs). It may be vital to decide which of the variables has a better discriminating value.<sup>17</sup>

Graduate students should be introduced to continuing medical education meetings and journal clubs and shown how to read the medical literature with critical appraisal and understanding of the p value.

#### PITFALLS IN IMPLEMENTATION

The major pitfalls are the slow uptake of biostatistical ideas by doctors, lack of understanding of basic mathematics, fear of innovation, rejection of new approaches and 'a prejudice that an understanding of biostatistics is not needed by doctors'.<sup>15</sup>

With the availability of free access to online statistical software many doctors believe they do not need any instruction in the subject.<sup>13</sup> Another important issue is the inability of biostatisticians to teach the subject in an easy-to-understand manner for doctors willing to adopt the subject. Most tutors of biostatistics are from non-medical background and lack a deeper understanding of the field of healthcare.<sup>15</sup>

#### CONCLUSION

Postgraduate education in biostatistics is presently a stand-alone subject during one semester. Based on our review we suggest integration of biostatistics with clinical subjects to facilitate the postgraduate teaching-learning process.

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