Teaching genetics to medical students

REPORT OF A WORKING PARTY OF THE CLINICAL GENETICS COMMITTEE OF THE ROYAL COLLEGE OF PHYSICIANS

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ABSTRACT – Rapid developments in molecular biology coupled with increased patient awareness and expectations emphasise the importance of ensuring that medical students are familiar with the principles of human genetics and their applications in clinical and preventive medicine. The present survey by the Royal College of Physicians of British medical schools revealed very variable teaching of genetics with a mean of 20 hours pre-clinical (range 2–66 hours) and 5.5 hours timetabled clinical teaching. Teaching was given by many different departments and was generally of unknown quality or clinical relevance. In contrast, a questionnaire survey of pre-clinical and clinical teachers in the main subjects and specialties demonstrated strong and consistent support for a genetic curriculum and the development of basic genetic skills by students by the end of the medical course. In view of this response, recommendations are made to institute a genetic core curriculum with a framework of timetabled clinical genetic teaching. It is also recommended that a Genetic Education Task Group be established to co-ordinate implementation and to ensure the clinical relevance of genetic teaching.

Medical geneticists claim that genetics is relevant to the practice of almost every specialty. Certainly the genetic consultation with its essential components of family history taking and diagnostic accuracy could be a model for ‘teaching the consultation’ to medical students. Molecular genetics has implications throughout medicine while patient awareness and expectations reinforce the need for medical students to be familiar with the principles of human genetics and their applications in preventive medicine.

The recent Report of the Royal College of Physicians working party on Prenatal Diagnosis and Genetic Screening [1] has shown the need for a screening and diagnostic service to be available throughout the country and has also emphasised the importance for more genetic education — from schools to the medical profession itself.

However, to justify a place for medical genetics in an already over-crowded curriculum, it is necessary to seek independent views as to its worth. The present study was therefore carried out to review genetic teaching in British medical schools and to sample the views of clinical and pre-clinical teachers in most of the major clinical and pre-clinical specialties and subjects.

Current teaching of medical genetics in Britain

To date, most information on the teaching of genetics has been obtained by the General Medical Council (GMC). The GMC survey of Basic Medical Education in 1975–76 [2] found that genetics was taught fairly extensively but often as part of integrated courses and sometimes with poor co-ordination. Certain aspects were duplicated, others were omitted altogether in a ‘too many cooks’ situation or because human genetics was not considered to be a topic in its own right which required overall monitoring. The report concluded:

‘In general, genetics is to be compared with anatomy or physiology in its role as an essential component of vocational training...’

The GMC envisaged a single, two-tier course for teaching genetics:

...the first stage... (would be) ... offered pre-clinically, the second in the clinical course but with the same staff responsible for both stages which would be co-ordinated to fulfil the ultimate objectives...

Later (1980) the GMC [3] recommended that:

...during instruction in all clinical subjects the students should be made aware of the influence of heredity on health and disease, both in terms of the individual and the population as a whole. He should learn the principles of genetic counselling, and also those governing the antenatal diagnosis and prevention of inherited disease and of mental retardation and/or handicap.

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More than four years later (1988), in spite of these recommendations, the GMC found considerable deficiencies in genetics teaching [4].

The present survey

A questionnaire study was undertaken between September 1988 and April 1989 to obtain more detail on the teaching of genetics and to see whether there was any agreement about the need for a genetic curriculum and the development of genetic skills by medical students. A total of 263 (61%) of those sent the questionnaires replied, and 240 (56%) completed the questionnaires (Table 1). An important feature of the data as a whole was the highly significant concordance in views of all specialties and the large number of written comments supporting genetic teaching (see full report).

Hours of teaching

The study revealed very variable teaching of genetics. There was a mean of 20 hours pre-clinical teaching (range 2-66 hours) and 5.5 hours timetabled clinical teaching (Table 2). Teaching was given by many different departments and was generally of unknown quality or clinical relevance.

Views of respondents

In contrast, pre-clinical and clinical teachers in the main disciplines expressed strong and consistent support for (a) a genetic curriculum, and (b) the development of basic genetic skills by students by the end of the medical course. The details were as follows.

Of the 25 topics which might be included in a pre-clinical course, 19 were considered 'valuable/obligatory' by two-thirds or more of respondents (Table 3) and none of these topics was rejected as 'of little value/not required' by more than 10%. The average percentage of respondents giving 'valuable/obligatory' to the top 19 topics was 84.6% and 'little value/not required' 3.7% (see full report for detail).

Of the 14 skills, 12 were considered 'valuable/obligatory' by two-thirds or more of respondents (Table 4) and none of these skills was rejected as 'of little value/not required' by more than 10%. The average percentage of respondents giving 'valuable/obligatory' to the top 12 skills was 82.5% and 'little value/not required', 5.0%.

Discussion

Medicine is exposed as never before to new clinical discoveries and new technologies so that doctors can no longer be expected to be totally familiar with all the facts and skills that are necessary for their patients' care. Greater technical complexity has also brought greater involvement of scientists and other paramedical professionals with whom doctors must work closely. Patients themselves are more questioning, less accepting of medical authority and more likely to resort to medical litigation. There is a greater sophistication in society concerning medical and ethical matters, while the introduction of general management into the Health Service has coincided with financial restraints and increased emphasis on audit and evaluation of clinical practice.

Medical courses must prepare doctors for these new challenges yet there is a generally appreciated need to reduce the load of factual material and shift from passive to active learning. McCormick [6] observes that medical schools currently over-value training and under-value education, scholarship and the critical mind.

Table 1. Sample population

| Specialty subject       | No. who received questionnaire | No. replied | No. (%) replied | No. completed | Total responses (%) | Written comments |
|-------------------------|--------------------------------|-------------|-----------------|---------------|---------------------|-----------------|
| Anatomy                 | 34                             | 17(50)      | 15(44)          | 6.3           | 10                  |
| Biochemistry            | 29                             | 12(41.4)    | 11(38)          | 4.6           | 5                   |
| Genetics                | 28                             | 18(64.3)    | 18(64)          | 7.5           | 12                  |
| Clinical Genetics (incl 10 non-med) | 39                      | 38(97)      | 31(80)          | 12.9          | 14                  |
| Medicine (incl specialties) | 73                          | 51(70)      | 47(64)          | 19.6          | 25                  |
| General practice        | 21                             | 16(76)      | 16(76)          | 6.7           | 5                   |
| Obstetrics and gynaecology | 36                      | 29(80.6)    | 26(72)          | 10.8          | 14                  |
| Paediatrics             | 47                             | 31(66)      | 26(55)          | 10.8          | 17                  |
| Psychiatry              | 47                             | 24(51)      | 24(51)          | 10.0          | 12                  |
| Surgery                 | 49                             | 10(20)      | 10(20)          | 4.2           | 4                   |
| Pathology               | 26                             | 17(65)      | 16(61)          | 6.7           | 10                  |
| **Total**               | **429**                        | **263(61)** | **240(56)**     | **100.0**     | **128**             |

*Genetics refers to 28 non-medical professors of genetics not involved in medical genetics teaching but selected because of their expert knowledge.
Table 2. Timetabled genetics teaching in medical schools in Britain

| School                        | Pre-clinical Hours | Clinical Hours | Hum/Med Genetics Professor | Scheduled visits to Gen Clinic |
|-------------------------------|--------------------|----------------|----------------------------|-------------------------------|
| Aberdeen                     | 25.00              | 6.00           | No                         | Yes                           |
| Belfast                       | 26.00              | 8.00           | Yes                        | Yes                           |
| Birmingham                   | 3.00               | 3.50           | No                         | Yes                           |
| Bristol                      | 5.00               | 2.00           | No                         | No                            |
| Cambridge                    | 12.00              | 1.50           | Yes\(^a\)                  | No                            |
| CharX/Westm                  | 12.00              | 7.00           | No                         | No                            |
| Dundee                       | 26.00              | 1.00           | No                         | No                            |
| Edinburgh                    | 2.00               | 6.00           | Yes                        | No                            |
| Glasgow                      | 26.00              | 12.00          | Yes                        | Yes                           |
| Kings College                | 18.00              | 1.00           | No                         | No                            |
| Liverpool                    | 16.00              | 0.00           | No                         | No                            |
| London Hospital\(^b\)        | 25.00              | 0.00           | No                         | No                            |
| Leicester                    | 66.00              | 2.00           | No                         | No                            |
| Leeds                        | 12.00              | 2.00           | No                         | Yes                           |
| Manchester                   | 27.00              | 5.00           | Yes                        | Yes                           |
| Newcastle                    | 18.00              | 11.00          | Yes                        | Yes                           |
| Nottingham                   | 15.00              | 6.00           | Yes (1990)                 | Yes                           |
| Oxford                       | 20.00              | 8.00           | Yes\(^c\)                  | Yes                           |
| Royal Free                   | 20.00              | 14.00          | No                         | Yes                           |
| St Andrews\(^d\)             | 20.00              | 5.00           | No                         | Yes                           |
| St Bartholomews              | 14.00              | 2.00           | No                         | Yes                           |
| Sheffield                    | 24.00              | 16.00          | No                         | No                            |
| St Georges                   | 15.00              | 2.00           | No                         | No                            |
| St Mary’s                    | 50.00              | 0.00           | No                         | No                            |
| Southampton                  | 7.00               | 11.00          | No                         | No                            |
| UCH/Middlesex                | 17.00              | 6.00           | Yes\(^e\)                  | Yes                           |
| Wales                        | 12.00              | 12.00          | Yes                        | Yes                           |

(mean)20.14 (mean)5.57 10/28 14/28

\(^a\)Current Cambridge Professor of Pathology is a clinical geneticist but is not responsible for pre-clinical genetic teaching
\(^b\)London Hospital Medical School data 1986
\(^c\)Current Oxford Professor of Genetics is a clinical geneticist
\(^d\)St Andrews students go to Manchester for their clinical course
\(^e\)Galton Chair of Human Genetics

It is against this background that the present study must be judged. The study has in fact found remarkable support amongst both pre-clinical and clinical teachers in all disciplines for most core topics (Table 3) and skills (Table 4), with particularly high scores for general core topics and skills and relatively low scores for specialised and technical topics and skills.

Validity of the data

Although there must be caution about any postal questionnaire, there are good reasons for believing in the validity of the data reported here. There was an excellent response rate (Table 1) and very similar results were obtained from individuals who replied to a reminder. The sample was believed to be adequately representative because of the consistency of the high scores and the rank orders from all of a wide range of non-medical geneticists, pre-clinical and clinical professors and from a sample of NHS neurologists. The great majority of written comments were positive, including those that were not accompanied by a completed questionnaire (see full report).

Clinical relevance of pre-clinical teaching

Many of the respondents to the present study commented on the need to ensure that pre-clinical teaching is clinically relevant and avoids becoming an intimidating mass of unrelated facts. Some contrary views came from pre-clinical teachers who suggested that topics with a clinical bias should be taught in the clinical or post-graduate courses.

The average number of hours of timetabled clinical
Table 3. Views of respondents on genetic core curriculum topics (Only the main topics were included: detail will vary between medical schools. The aim is to encourage the development of the skills listed in Table 4.)

| Topic                                      | Respondents awarding 'valuable/obligatory' score (%) |
|--------------------------------------------|-----------------------------------------------------|
| Patterns of inheritance                    | 97.9                                                |
| Genetics of common disease                 | 97.5                                                |
| Chromosome structure and function          | 95.8                                                |
| Medical applications of molecular genetics | 92.9                                                |
| Pre-natal diagnosis                        | 92.0                                                |
| Malformations                              | 91.2                                                |
| Genetic counselling                        | 90.3                                                |
| Cell division                              | 89.9                                                |
| Chromosome aberrations                     | 89.5                                                |
| Sex determination                          | 89.1                                                |
| Prevention of genetic disease              | 86.1                                                |
| Inborn errors of metabolism                | 83.6                                                |
| Structure of human genome                  | 82.4                                                |
| Mutations                                  | 81.1                                                |
| Immunogenetics/HLA                         | 73.9                                                |
| Linkage                                    | 70.6                                                |
| Population genetics                        | 70.2                                                |
| Risk calculation                           | 68.1                                                |
| Protein synthesis                          | 66.0                                                |
| Gene mapping                               | 65.5                                                |
| Twinning                                   | 63.9                                                |
| Pharmacogenetics                           | 59.7                                                |
| Genetic services and medical audit         | 52.1                                                |
| Basic molecular techniques                 | 51.3                                                |
| Karyotype preparation                      | 46.2                                                |

Teaching was only 5.78, although anecdotally some genetics was included in paediatrics, obstetrics and other specialties. This could be of high quality and be clinically relevant, but we agree with the GMC that it is haphazard and cannot easily be verified and that the same teachers should co-ordinate both pre-clinical and clinical genetics teaching. Such teachers must be both genetically literate and clinically trained.

This study was concerned with teaching for medical students in general and does not consider the special needs of students who wish to study genetics in more detail. For them, elective periods, intercollocated honours degrees and perhaps MD–PhD courses may be available.

Recommendations

1. The findings of this study provide strong support for improved teaching of genetics to medical students and give clear guidelines for curriculum contents.
2. The pre-clinical curriculum should reflect the scores awarded by the multi-disciplinary sample of respondents (see Table 3). Some minor revisions may be required in the light of written comments.
3. Teaching of genetics in anatomy and biochemistry and by non-medical geneticists should not be discouraged, but its relevance should be reviewed in collaboration with clinical geneticists.
4. In the clinical genetics course we recommend a core of timetabled genetic teaching sessions designed to develop those skills given high scores by respondents (see Table 4). The clinical syllabus is considered in detail in the full report.
5. Clinical geneticists should be involved in both pre-clinical and clinical teaching and should help to co-ordinate genetic teaching in integrated courses and by other clinical specialists.

Table 4. Views of respondents on genetic skills
(Scores reflecting importance to medical students on which they might build as doctors)

| Skill                                                      | Respondents awarding 'valuable/obligatory' score (%) |
|------------------------------------------------------------|-----------------------------------------------------|
| Know where to obtain information and help                  | 95.4                                                |
| Be able to construct a family tree and understand the patterns of inheritance | 91.2                                                |
| Perceive major ethical issues in medical genetics          | 91.2                                                |
| Be aware of the stress of genetic disease in families      | 90.8                                                |
| Discuss role of genetics in common disease                 | 89.1                                                |
| Understand the concept of genetic heterogeneity            | 80.3                                                |
| Recognise genetically high risk pregnancies                | 78.2                                                |
| Understand genetic papers in general journals              | 76.2                                                |
| Understand principles of non-directive genetic counselling | 75.3                                                |
| Be aware of wide range of clinical normality               | 74.9                                                |
| Be able to interpret a chromosome report                   | 74.5                                                |
| Be aware of organisation and location of genetic centres   | 75.3                                                |
| Be aware of need for audit                                 | 55.2                                                |
| Be able to interpret DNA report and understand difference between gene tracking and direct gene analysis | 42.7                                                |
6. Genetics teaching in paediatrics, obstetrics and other clinical specialties should continue with greater participation from clinical geneticists where possible. Awareness of genetics by other clinical teachers should be raised by participation by clinical geneticists in medical staff rounds.

7. There should be a formal assessment of genetics at the end of the pre-clinical course and by genetic questions in appropriate parts of the final examination preferably provided by clinical geneticists at both stages.

8. For these recommendations to be implemented, urgent attention must be given to increasing the number of clinical genetics staff available for teaching.

9. We recommend that implementation should be coordinated nationally by a Genetic Education Task Group (GETG) to accelerate the pace of genetic education (see full report for details). This group will recognise the prerogative of individual schools to decide their own curricula and methods of teaching. GETG will also note the conclusions of the task force set up by the American Society of Human Genetics [5] which doubted the effectiveness of pronouncements unsupported by practical assistance.

A full version of the Report 'Teaching Genetics to Medical Students' is available from the Royal College of Physicians, priced £5.00. (Overseas £7.00 or US$15.00)

References

1. Royal College of Physicians (1989) Prenatal diagnosis and genetic screening: community and service implications (Report of a working party). London: Royal College of Physicians.

2. General Medical Council (1977) Basic medical education in Britain (Report of the General Medical Council survey of basic medical education in the UK and the Republic of Ireland, 1975–6). London: Nuffield Provincial Hospitals Trust.

3. General Medical Council Education Committee (1980) Recommendations on basic medical education. London: General Medical Council.

4. General Medical Council Education Committee (1988) Report of a survey of medical education practices in United Kingdom medical schools. London: General Medical Council.

5. Graham, J. M. Jr, Rotter, J. I., Riccardi, V. M. et al. (1989) Report of the task force on teaching human genetics in North American medical schools (Feature article). American Journal of Human Genetics 44, 161–5.

6. McCormick, J. (1988) The academic task. Lancet 6 August, 326.