Medical Education in the Anatomical Sciences: The Winds of Change Continue to Blow

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At most institutions, education in the anatomical sciences has undergone several changes over the last decade. To identify the changes that have occurred in gross anatomy, microscopic anatomy, neuroscience/neuroanatomy, and embryology courses, directors of these courses were asked to respond to a survey with questions pertaining to total course hours, hours of lecture, and hours of laboratory, whether the course was part of an integrated program or existed as a stand-alone course, and what type of laboratory experience occurred in the course. These data were compared to data obtained from a similar survey in 2002. Comparison between the data sets suggests several key points some of which include: decreased total hours in gross anatomy and neuroscience/neuroanatomy courses, increased use of virtual microscopy in microscopic anatomy courses, and decreased laboratory hours in embryology courses. Anat Sci Educ 2:253–259, 2009. © 2009 American Association of Anatomists.

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INTRODUCTION

Anatomy education has always been regarded as an essential requirement in the medical curriculum. In fact, in early medical education in the United States, anatomy by itself constituted preclinical education (Bardeen, 1905). In the 1909 report to the Council on Medical Education of the American Medical Association (Bardeen, 1909), gross anatomy occupied about one-fifth of the medical curriculum, accounting for more than 800 hours of lectures and laboratories with a number of schools still having more than 1,000 hours of anatomy instruction (Eldred and Eldred, 1961). However, beginning with the Flexner report (1910), there was a separation of preclinical and clinical studies, as other basic science disciplines increased in importance. This led to a reduction in the time devoted to anatomical sciences, and a report in 1923 by the American Association of Medical Colleges (AAMC) recommended that the time devoted to Anatomy should be restricted to 471–814 hours (Reid, 1931; Eldred and Eldred, 1961). Additionally, in 1927 Zapffe proposed an integrated curriculum based on a 1923 report from the AAMC (Zapffe, 1927), in which anatomy teaching was vertically integrated in all four years of medical curriculum and restricted to 566 hours. Included in this integrated program was gross and microscopic anatomy in year one, topographic anatomy in year two, and clinical anatomy in years three and four incorporated to medicine and surgery clerkships. This innovative curriculum was not widely accepted by medical schools and had no impact on basic science education. A few years later Reid (1931) reported that the average time devoted to anatomy teaching was still around 780 hours (480–1185 range).

The time between the early 1930s and late 1980s can be characterized as an uncomfortable status quo (Pawlina, 2009). During this time, teaching hours gradually decreased, traditional teaching methods continued to prevail, basic science instruction lacked clinical relevance, and any integration with clinical instruction caused dissonance and dissatisfaction among preclinical teachers and students alike (McLaren, 1980). Most of anatomy was taught in a passive, lecture-based format by classically trained anatomists who felt uncomfortable trying to put their teaching into clinical contexts (McCrorie, 2000).

However, beginning in the early 1990s, medical curricula slowly began to change from a conventional, subject-based approach to a multisubject, integrated approach (Schmidt,
As the health care delivery system in the United States undergoes changes, leaders in academic medicine have embraced curricular changes to prepare future physicians to meet society’s health needs (O’Connell and Pascoe, 2004; Cortese and Smoldt, 2006). Today there are many driving forces behind curricular reform. These include decreasing weekly contact hours, increasing subject matter integration, increasing clinical faculty interaction in the early years of medical school, and making use of the vast array of electronic and technological advances. Instead of traditional discipline-based courses, the movement is toward interdisciplinary science courses and integrated basic science/clinical courses (Drake, 1998). Instead of lecture-based presentation styles, current trends suggest using interactive approaches such as team-based learning (Vasan et al., 2008), small group interactive sessions (Chan and Ganguly, 2008), and problem-based and case-based learning (Yiou and Goodenough, 2006; Philip et al., 2008).

The purpose of this survey was to obtain data on how education in the anatomical sciences has transformed within the last decade. What has happened since the previous survey in 2002 (Drake et al., 2002)? Have course hours decreased? Has there been a change in presentation styles? Are laboratories being modified or eliminated? Detailed information related to these questions is important and will allow course directors and faculty to be better informed as decisions are being made.

**METHODS**

Online surveys were constructed to gather basic information about gross anatomy, microscopic anatomy, neuroscience/neuroanatomy, and embryology courses. These surveys were similar to the paper survey used in a previous report by Drake et al. (2002). Similar online surveys have been used over the past few years to continuously gather course data on the American Association of Anatomists website (AAA, 2009). Typical information requested included total course hours, number of lecture hours, number of laboratory hours, a brief description of the course, and other questions specific for each course. Demographic data were also collected related to the number of students and faculty participating in the course. A few new questions were added including “does your course assess competencies other than medical knowledge, e.g., professionalism, interpersonal and communication skills, etc.?”

To obtain a response from as many course/program directors as possible, several different approaches were used. First, a notice about the survey, which also contained a link to the survey, was posted on the American Association of Anatomists (AAA) and the American Association of Clinical Anatomists (AACA) electronic mailing lists. Second, a notice was distributed to members of the Association of Anatomy, Cell Biology, and Neurobiology Chairpersons (AACBNC) group. Third, all of the individuals on a list of course directors compiled by the AAA were contacted. Finally, after receiving a large number of responses, a list of individuals at institutions that had not responded was generated, and these persons were contacted and asked to get in touch with the appropriate course directors at their institution.

The data published in this survey have been restricted to allopathic and osteopathic medical schools in the United States. Using only this segment of data allowed a direct comparison to the results from a previously reported survey (Drake et al., 2002), focused on programs with similar objectives and removed any type of specifically directed or government mandated educational programs. Additional data obtained from medical schools outside the United States, undergraduate institutions, and allied health programs are posted on the AAA web site (AAA, 2009).

**RESULTS**

**Survey Response**

Currently, there are a total of 130 allopathic and 25 osteopathic medical schools in the United States. The number of responses obtained for this survey in each of the courses is identified in Table 1. Each of the four courses surveyed included questions about total course hours, hours of lecture, and hours of laboratory, whether the course was part of an integrated program or existed as a stand-alone course, and what type of laboratory experience occurred in the course.

**Gross Anatomy**

In this survey, 19 of the gross anatomy courses reported that they were part of an integrated approach and 46 indicated that gross anatomy was a stand-alone course. Additionally, 60 courses used a regional approach in the teaching of gross anatomy, while five used a systemic approach. The total course hours, not including examination hours, reported by the participants in the survey averaged 149 (SD = 36) with a range of 56–231 (Fig. 1). The average number of lecture hours was 43 (SD = 19) with a range of 0–78, and the average number of laboratory hours was 94 (SD = 29) with a range of 20–160 (Fig. 1).

Regarding the laboratory experience, of the 65 respondents to the gross anatomy course survey, 38 reported that...
their laboratory used a student dissection approach, and a combination of student dissection and prosection (or previously dissected) was reported by 25 respondents. Two respondents indicated that their laboratory used a prosection (or previously dissected) only approach.

Microscopic Anatomy

In this survey, 22 of the microscopic anatomy courses reported that they were part of an integrated approach, and 23 indicated that microscopic anatomy was a stand-alone course. The total course hours, not including examination hours, reported by the participants in the survey averaged 73 (SD = 29) with a range of 11–136 (Fig. 2). The average number of lecture hours was 35 (SD = 17) with a range of 0–82, and the average number of laboratory hours was 35 (SD = 16) with a range of 0–88 (Fig. 2).

Regarding the laboratory experience, of the 45 respondents, 13 reported that their laboratory used microscopes, 20 reported that their laboratory used virtual microscopy, and 12 reported that their laboratory used a combination of microscopes and virtual microscopy.

Neuroscience/Neuroanatomy

In this survey, 12 of the neuroscience/neuroanatomy courses reported that they were part of an integrated approach, and 19 indicated that neuroscience/neuroanatomy was a stand-alone course. The total course hours, not including examination hours, reported by the participants in the survey averaged 79 (SD = 33) with a range of 30–160 (Fig. 3). The average number of lecture hours was 52 (SD = 28) with a range of 0–150, and the average number of laboratory hours was 15 (SD = 12) with a range of 0–47 (Fig. 3).

Embryology

In this survey, 34 of the embryology courses reported that they were part of an integrated approach, and nine indicated that embryology was a stand-alone course. The total course hours, not including examination hours, reported by the participants in the survey averaged 17 (SD = 12) with a range of 0–68 (Fig. 4). The average number of lecture hours was 15 (SD = 10) with a range of 0–54 (Fig. 4). Only three of the 43 programs responding to the survey described a laboratory experience.

Historical Comparisons

To gain insight into the changes in total course hours that have occurred from 1955 to 2009, data were gathered from a number of previous surveys and compared to data collected from the current survey in Figures 5–8. Figure 5 shows the distribution of total gross anatomy course hours (Berry et al., 1956; Kahn et al., 1966; Blevins and Cahill, 1973; Collins et al., 1994; Drake et al., 2002; Gartner, 2003). Figure 6 shows the distribution of total microscopic anatomy course hours (Berry et al., 1956; Kahn et al., 1966; Hightower et al., 1999; Drake et al., 2002; Gartner, 2003). Figure 7 shows the distribution of total neuroscience/neuroanatomy course hours (Berry et al., 1956; Kahn et al., 1966; Drake et al., 2002; Gartner, 2003). Figure 8 shows the distribution of total embryology course hours (Berry et al., 1956; Kahn et al., 1966; Drake et al., 2002; Gartner, 2003).

Other Questions

There was a question in the survey related to demographic information such as number of students and faculty participating in each course. Although data were collected on this topic, it was more for information purposes and is not being discussed in this article. Similarly, a new question was asked to determine whether courses in the anatomical sciences were assessing competencies such as professionalism and communication skills. The low number of responses to this question in each of the courses did not provide enough information to draw any meaningful conclusions.
DISCUSSION

Response to the Survey

One of the important questions asked when the results of this type of survey are evaluated is whether the information collected is comprehensive and representative. Thus, the first number looked at is the response rate and, although we had hoped for larger participation, our results are similar to the norm for surveys that use a questionnaire to gather information. Baruch and Holtom (2008) analyzed 490 studies using surveys, and the average response rate from individuals was around 50% with a standard deviation around 20%. In the same report, studies surveying organizational representatives or top management, possibly analogous to course directors, had an average response rate of around 36% (SD = 19%). Similar results were also obtained in an earlier study by Baruch (1999). Based on these data, response rate cannot be the only factor considered because it depends entirely on two factors: (1) the individual must have received the questionnaire and (2) the individual, in this case a course director, must be willing to fill it out.

In the current survey, other factors considered to assure that our results are comprehensive and representative include receiving responses from all parts of the United States, receiving responses from both private and public institutions, and receiving responses from both large and small programs. All

Figure 3.
Neuroscience/Neuroanatomy survey results for total course hours, average lecture hours, and average lab hours.

Figure 4.
Embryology survey results for total course hours and average lecture hours.

Figure 5.
Distribution of total gross anatomy course hours from 1955 to 2009.

Figure 6.
Distribution of total microscopic anatomy course hours from 1955 to 2009.
of these criteria were satisfied, and we are confident that our results provide an up-to-date and accurate picture of how the anatomical sciences are being taught in medical school programs in the United States.

One additional point should be mentioned. We do feel that the lower response rate in this survey compared with the previous survey (Drake et al., 2002) may be due to a decrease in the number of Departments of Anatomy around the United States and the more integrated nature of the curriculum at many medical schools. The appropriate individuals may not have received the questionnaires or been inclined to fill them out. This may be particularly true for the low response rate in neuroscience/neuroanatomy courses.

Trends

Gross anatomy. When the survey results for gross anatomy courses were examined, the only remarkable change was in total course hours. These numbers decreased ~11% when the current results, 149 hours, were compared to the 2002 survey results, 196 hours. Breaking it down, there was little change in the percentage of course hours devoted to lectures, and laboratory experience was still a major component of the course (~63%). Additionally, the majority of courses still used a regional approach (94%), the majority of courses were not part of an integrated curriculum (71%), and all 65 respondents (100%) reported that they still had some type of cadaver experience.

Looking more closely at this, 40 programs reported that they used student dissections exclusively, 23 programs used a combined student dissections/prosection (or previously dissected) approach, and two programs indicated that their laboratory experience was a prosection only (or previously dissected) approach at least in the first year. One question raised related to these results is did courses using prosection only (or previously dissected) approaches have fewer total course hours and fewer laboratory hours than courses using student dissection or student dissection/prosection approaches? The answer to this question is yes. This conclusion was reached after comparing the following data: total course hours in a prosection only approach (96 hours), total course hours in a student dissection/prosection course (151 hours) and laboratory hours in a prosection (or previously dissected) course (66 hours), laboratory hours in a student dissection/prosection course (94 hours). Although course and laboratory hours do seem to be reduced in a prosection (or previously dissected) course compared with a course with student dissection/prosection, these differences were not statistically significant.

Evaluating the gross anatomy survey data from 1955 to 2009 (Fig. 5) presents an interesting story of progressive change. Over a period of 49 years, there has been a 55% decrease in total course hours used to teach gross anatomy, with the most dramatic reduction occurring between 1955 and 1973. From 1973 to 2009, a small decrease has continued. However, the decrease has slowed significantly and appears to be reaching a plateau. Is it possible that the hours required to maintain a gross anatomy course with a laboratory in which students dissect are being approached? If lecture hours from previous surveys (Drake et al., 2002; Gartner, 2003) are compared with the results from the current survey, they have not decreased substantially from 1973. However, laboratory hours dropped significantly from 1967 to 1995 and then began to level off. It would appear that any further significant reductions in course hours will probably come at the expense of the students’ dissection experience.

Microscopic anatomy. Microscopic anatomy courses showed minimal changes when the current survey results were compared with the previous survey (Drake et al., 2002). Total course hours were similar in the two surveys, 73 vs. 79, and the split between lecture and laboratory components of the course was roughly 50% in both surveys. The big difference was in microscopy use. In the current survey, 44% of the respondents indicated that they used only virtual microscopy, whereas this number was only 14% in the 2002 survey. This is a significant shift which may have been implemented to increase class efficiency, decrease supply costs, and/or increase student access.

A final important change that has occurred is the presentation of microscopic anatomy as part of an integrated program. Although this question was not asked in the 2002 survey, almost 50% of the respondents in the current survey indicated that their course was part of an integrated program.

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Figure 7.
Distribution of total neuroscience/neuroanatomy course hours from 1955 to 2009.

Figure 8.
Distribution of total embryology course hours from 1955 to 2009.
When the survey data from 1955 to 2009 for microscopic anatomy are reviewed (Fig. 6), the decline in total course hours has slowed but continues. A suggested reason for this might be that microscopic anatomy lends itself to approaches that are more independent study friendly. This is especially true with the continued increased usage of virtual microscopy systems that students can access anywhere by computer.

Neuroscience/Neuroanatomy. Courses in the neuroscience/neuroanatomy discipline had the largest drop in total course hours when compared with the previous survey (Drake et al., 2002). In the current survey, the average total course hours were 79 (SD = 33), whereas in the previous survey, they were 96 (SD = 37). This represents an 18% drop and may be directly related to a decrease in the amount of laboratory time in current neuroscience/neuroanatomy courses. The total laboratory hours reported in the current survey were 15 (SD = 12) with a range of 0–47. In the previous survey, the mean of total laboratory hours was ~25–28, with a range of 0–82. The higher mean and larger range support the suggestion that a major component of the decrease in total course hours was probably due to a sizable decrease in laboratory hours. Additionally, the question was asked whether the integrated neuroscience/neuroanatomy courses had fewer total course hours than the stand-alone courses. When this comparison was made, both types of courses averaged approximately the same number of total course hours.

Looking at the survey data from 1955 to 2009 (Fig. 7), there was an initial decline between 1966 and 1973, and then total course hours seemed to level off at about 80 hours to the present, except for a slight increase in 2002. This increase in 2002 may relate to the change toward multidisciplinary courses, which included neuroanatomy, neurophysiology, etc., that occurred around that time. This confluence of topics may have resulted in an increase in course hours as all of these disciplines combined to be presented together. The drop from 2002 to 2009 may relate to increased efficiency in this educational approach and, as mentioned earlier in this section, a continued decrease in laboratory hours.

Embryology. Embryology courses appeared to be the least changed from the previous survey. The average total course hours were 17 (SD = 12) in the current survey and 16 (SD = 11) in the previous survey (Drake et al., 2002), and the majority of respondents again indicated that embryology was part of an integrated approach. Regarding this aspect of the results, the question was asked as to whether the stand-alone courses were longer than the courses that were part of an integrated approach. When this comparison was made, stand-alone 27 hours vs. integrated 15 hours, the tendency was yes, but the difference was not statistically significant. The one change that was observed in this survey was in the number of embryology courses that still have a laboratory. This number has decreased further from 13% of the respondents in the first survey (n = 69) to 7% (3 of 43 programs) of the respondents in the current survey.

Looking at the summary of data from 1955 to 2009 (Fig. 8), the rapid decline in total course hours that occurred between 1955 and 1973 has leveled off, and embryology courses have maintained an average of just below 20 for over three decades. The significance of this number is that it may actually represent a minimum amount of time necessary to provide a fundamental level of knowledge for the undifferentiated physician about this subject and its clinical relevance.

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LITERATURE CITED


