

Designing Anatomy Program in Modern Medical Curriculum: Matter of Balance

Ivica Grković, Maja Marinović
Guić, Vana Košta, Ana
Poljičanin, Ana Čarić,
Katarina Vilović

Department of Anatomy, Histology,
and Embryology, University of Split
School of Medicine, Split, Croatia

Aim To evaluate the structure of the anatomy program in the first year medical curriculum of University of Split School of Medicine by comparing it with the recommendations by the Educational Affairs Committee of the American Association of Clinical Anatomists (AACCA) and the Terminologia Anatomica (TA); we also quantitatively evaluated the organization of teaching material in contemporary topographical anatomy textbooks and matched them with the AACCA recommendations, TA, and the curriculum of the anatomy course taught at Medical School in Split, Croatia.

Methods TA, official recommendations of the AACCA, 6 contemporary anatomy textbooks, and the structure of the anatomy course were analyzed for the proportion of the terms or text devoted to standard topographical regions of the body. The findings were correlated using Spearman ρ test.

Results The curriculum outline correlated both with the AACCA recommendations (Spearman $\rho=0.83$, $P=0.015$) and TA (Spearman $\rho=0.73$, $P=0.046$). Textbooks contained 8 distinct sections, 7 allocated to topographic anatomy regions and 1 to general anatomy concepts and principles. The structure of all textbooks correlated significantly with the course curriculum. However, 4 out of 6 textbooks did not correlate with TA and only a single textbook showed significant correlation with the AACCA recommendations.

Conclusion Anatomy textbooks vary in the amount of text dedicated to different parts of topographical anatomy and are not quite concordant with curriculum recommendations and standard anatomical terminology. Planning the structure of an anatomy course should not be based on a single book or recommendation but on evidence.

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Correspondence to:

Ivica Grković
Department of Anatomy, Histology
and Embryology
University of Split School of
Medicine
Šoltanska 2
21000 Split, Croatia
igrkovic@mefst.hr

A world-wide shift toward problem-based learning in medicine and/or requirements of the higher education harmonization at European universities (1) caused radical changes affecting the shape and the size of contemporary medical curricula. The profession still agrees that anatomy remains one of the pillars of medical education (2), hence the way anatomy teaching fits recent changes deserves particular attention. There are two directly competing realities concerning the pre-clinical years: fast expansion of knowledge in basic medical disciplines, requiring more teaching time, and a strong tendency to reduce teaching time, particularly in problem-based curricula (3). Within anatomy itself, there is a "competition for space and time" between recently introduced but quickly accepted perspectives (eg, surface and imaging anatomy, applied and clinical anatomy, anatomical variations) that are becoming an integral part of the anatomy teaching.

What is the experience with all these changes in a small medical school? In accordance with the agreement that all 4 medical schools in Croatia synchronize their curricula, so that the European Credit Transfer System can be introduced (4), we decided in 2005 to overhaul medical curricula both quantitatively and qualitatively. Only then did it become apparent that the structure of the anatomy program is something we do not think about until we have to change its structure, although we teach the structure of the human body. Two hundred teaching hours were allocated to the subject and the material had to follow recommendations outlined in the Catalogue of Knowledge and Skills for Medical Studies (5), accepted by all 4 medical schools in Croatia. Compared with some modern anatomy curricula (6-8), we had considerably more teaching hours, so we believed we had space for creating a modern, all-inclusive anatomy curriculum. Among numerous organizational questions, perhaps the most pressing one was that of the optimal division of the subject material. How many teaching units should be allocated to different body regions – the abdomen, the thorax, or head and neck region, for example? What about the representation of general anatomical principles? To answer these questions, we performed an extensive literature search with the aim of finding examples of "optimally balanced anatomy curricula" for medical students. We could not find such directions in the literature and decided to analyze available textbooks and curricula recommendations. Although there are publications dealing with the "adjustment" of anatomy programs to newly designed medical curricula (3,9), particularly to the problem-based (10,11) and team-based learning (12), only the publication by the Educational Affairs

Committee of the American Association of Clinical Anatomists (AACA recommendations) (13) proposes an outline of gross anatomy curriculum, mainly by listing relevant anatomical structures within defined regions of the body. Even though this document is more than 12 years old, it still represents a unique attempt to define an anatomy curriculum of the 21st century, as its title suggests. Although very comprehensive, even this publication could not help us with the question of the content organization. Keeping this problem in mind, we compared our curriculum, which was 3 years old, with the design of contemporary topographical anatomy textbooks (14-19). We decided to quantitatively assess them by measuring the amount of the text dedicated to different perspectives of anatomy and/or different regions of the body. The textbooks structure was also correlated with the AACA recommendations (13) and the current official anatomical nomenclature, Terminologia Anatomica (TA) (20), as well as with the structure of our curriculum.

MATERIALS AND METHODS

AACA recommendations, TA, and 6 contemporary anatomical textbooks, commonly used in graduate anatomy teaching, were included in the analysis. Using a topographic anatomy approach, the body was divided into 7 major anatomical modules; Thorax, Abdomen, Pelvis and Perineum, Head and Neck, Back, Upper Limb, and Lower Limb. A module is defined as a "large block of adjacent regions that can be studied together" (21). The eighth module – Introduction – included general anatomy facts and concepts applicable to all body regions (21).

We analyzed the following anatomy textbooks: Regional Anatomy Illustrated by Slaby et al. (14); Gross Anatomy in the Practice of Medicine by Smith et al. (15); Last's Anatomy by Sinnatamby and Last (16); Clinical Anatomy by Snell et al. (17); Clinically Oriented Anatomy by Moore and Dalley (18); and Gray's Anatomy by Drake et al. (19). Quantification of the teaching material was performed by determining the representation ratio of the 8 modules, expressed as the percentage of the total content. The body of text in all textbooks was organized in 2 columns per page. We counted the number of text rows in each module. Incomplete rows were counted only if exceeding half of their length. Titles and subtitles were not counted. Text related to clinical anatomy was counted as a separate segment of the associated module. The number of rows per region was presented both as absolute numbers and as relative percentage values for each entity counted. In

this way we obtained the percentage representation of each region and were able to perform a comparison between different textbooks. Pictures and picture-associated text were not taken into account in this study.

Regarding quantitative analysis of the AACA recommendation and TA, we counted the anatomical terms listed and displayed them as both absolute values and percentages. In TA, the anatomical terminology related to the internal features (*Morphologia interna*) of the central nervous system section was not included in the counts. Despite a system-based organization of the TA, it was not difficult to decide in which module (or region) a part of certain system should be placed.

Different modules of the curriculum were presented as the number of student teaching hours.

Non-parametric correlation test using raw data (Spearman ρ) was performed, and the correlation coefficient was calculated using InStat3 software (GraphPad, La Jolla, CA, USA).

RESULTS

Curriculum vs AACA recommendations and TA

When our curriculum was compared with the AACA recommendations and TA, variations between some modules were observed (Table 1). Percentage representation of the Pelvis and Perineum block in the course curriculum was lower than in both the AACA recommendations and TA, whereas percentage representation of the Introduction was higher. For other modules, the number of teaching hours dedicated to them was almost identical (in Abdomen and Lower Limb) or was between values representing their terminology in the AACA recommendations and TA (in Thorax, Upper limb, Head and Neck, and Back).

Table 1. Content quantification of American Association of Clinical Anatomists (AACA) recommendations, Terminologia Anatomica (TA), and anatomy curriculum at the Department of Anatomy, University of Split School of Medicine*

Source	No. (%) of terms in		No. (%) of hours Anatomy curriculum
	AACA recommendations	Terminologia anatomica	
Introduction	131 (5)	337 (5)	14 (7)
Thorax	331 (14)	631 (9)	20 (10)
Abdomen	280 (12)	746 (11)	24 (12)
Pelvis and perineum	248 (10)	655 (9)	12 (6)
Upper limb	251 (11)	530 (8)	20 (10)
Lower limb	240 (10)	629 (9)	20 (10)
Head and neck	817 (34)	3280 (47)	82 (41)
Back	87 (4)	106 (1)	8 (4)
Total	2385	6914	200

*Percentages in columns do not add up to 100 because of rounding.

Table 2. Quantification of textbook text dedicated to different topographical anatomy modules*

Textbook module	No (%) of rows in					
	Snell RS et al. Clinical Anatomy (17)	Sinnatamby CS. Last's Anatomy (16)	Drake RL et al. Gray's Anatomy (19)	Moore KL, Dalley AF. Clinically Oriented Anatomy (18)	Slaby F et al. Gross Anatomy in the Practice of Medicine (15)	Smith JW et al. Regional Anatomy Illustrated (14)
Introduction	1203 (5)	2280 (7)	2262 (9)	2682 (9)	1315 (9)	82 (0.5)
Thorax	2250 (10)	2510 (8)	2361 (9)	3311 (11)	2366 (17)	2705 (12)
Abdomen	3253 (15)	4049 (13)	2536 (10)	4327 (14)	1737 (12)	2938 (13)
Pelvis and perineum	2268 (10)	2753 (9)	2118 (8)	3466 (11)	961 (7)	1801 (8)
Upper limb	2918 (13)	4072 (13)	3174 (12)	4218 (13)	1921 (13)	3105 (14)
Lower limb	2918 (13)	4074 (13)	3214 (12)	4746 (15)	2520 (18)	2782 (13)
Head and neck	6160 (28)	10 198 (32)	8708 (34)	6906 (22)	2914 (20)	8364 (38)
Back	968 (4)	2051 (6)	1362 (5)	1668 (5)	574 (4)	340 (2)
Total	21 938	31 987	25 735	31 324	14 308	22 117

*Percentages in columns do not add up to 100 because of rounding.

TABLE 3. Correlation (Spearman ρ) of the structure of American Association of Clinical Anatomist (AACA) recommendations, Terminologia Anatomica, and anatomy curriculum at the Department of Anatomy, University of Split School of Medicine, with 6 anatomy textbooks

Program	Textbook*					
	Sinnatamby Snell RS et al. Clinical Anatomy (17)	CS, Last RJ. Last's Anatomy (16)	Drake RL et al. Gray's Anatomy (19)	Moore KL, Dalley AF. Clinically Oriented Anatomy (18)	Slaby F et al. Gross Anatomy in the Practice of Medicine (15)	Smith JW et al. Regional Anatomy Illustrated (14)
AACA recommendations (<i>P</i>)	0.719 (0.058)	0.595 (0.132)	0.619 (0.115)	0.619 (0.115)	0.690 (0.069)	0.762 (0.037)
Terminologia Anatomica (<i>P</i>)	0.802 (0.022)	0.643 (0.096)	0.524 (0.197)	0.738 (0.046)	0.524 (0.197)	0.643 (0.096)
Split School of Medicine anatomy curriculum (<i>P</i>)	0.884 (0.007)	0.781 (0.028)	0.878 (0.007)	0.830 (0.015)	0.830 (0.015)	0.854 (0.011)

*No. in brackets indicate *P* values.

Our curriculum outline correlated well with both the AACA recommendations (Spearman $\rho=0.83$, $P=0.015$) and TA (Spearman $\rho=0.73$, $P=0.046$) (Table 1).

Curriculum vs textbooks

All 6 textbooks contained 8 modules (or chapters); 7 dedicated to individual topographical anatomy region and 1 chapter devoted to general anatomy. The size of the chapters, their order of appearance in the book, as well as the organization within chapters varied among the textbooks (Table 2). For example, in Gross Anatomy in the Practice of Medicine (15), the Back region was difficult to separate from other regions, whereas in Regional Anatomy Illustrated (14) the Introduction was reduced to only a few pages dealing with the essentials of anatomical nomenclature and terms of comparison.

Out of 6 books included in this study, 4 (15,17-19) had parts of text devoted to clinical anatomy, which mainly included descriptions of relevant clinical cases and scenarios. The amount of clinical anatomy text varied from 16.3% (19) to 45.9% (15) of the total text.

When textbooks were compared with the AACA recommendations and TA, it was found that 4 textbooks did not correlate significantly with TA and that only a single textbook correlated significantly with the AACA recommendations (Table 3).

All 6 textbooks analyzed in this study correlated with our curriculum (Table 3), with two of them (Clinical Anatomy and Gray's Anatomy for Students) showing the highest correlation.

DISCUSSION

Before reorganizing or modernizing an anatomy curriculum or shape a new one within time limits set by the modern curriculum, perhaps the most important question should be that of the most optimal distribution of the "anatomical body of knowledge." An important step in answering this question is to work out how the shape and size of the human body correlates with the shape and size of the modern anatomy curriculum. Most publications concerning gross anatomy deal with issues of teaching methodology – from the instructional design principles in "anatomy of learning" (22) to relationships between learning outcomes and methods of anatomy teaching (23) or the assessment of different educational tools in learning anatomy in a problem-based learning curriculum (24). Particularly interesting are publications concerning the value of anatomical dissection as a teaching method in medical education, reviewed in a recent article by Winkelman (25). Models for innovative, integrated, and clinically oriented approaches to anatomy education have been proposed (26,27), attitudes of anatomy teachers toward changes of curriculum have been assessed (2,23), and quantity/structure of contact hours (lectures, tutorials, dissections) were compared between medical schools in the United States and Europe (7). Despite obvious ongoing interest in anatomy education in medical courses, to our knowledge, there is no practical guide about the content of anatomy curriculum and relative sizes of its parts in the literature. Recognizing this problem, Latman and Lanier (28) published recommendations (based on opinions of practicing clinicians) for gross anatomy course content for 3 allied health courses (occupational health, physician assistant, and physical therapy).

They summarized their results for both regional- and system-based gross anatomy curricula by proposing different percentages of content for each of the three courses. To the best of our knowledge, there is no similar reference for medical or dental courses.

When we designed our curriculum 4 years ago, we were aware of the AACA recommendations and of TA, but at that time we did not have the quantitative analysis of them. We composed the currently used anatomy program using a mixture of inputs: the recommended (system based) textbook (29), an Anatomy syllabus by our colleagues at Melbourne University (30), which is now a problem-based learning-based course, and also our wide teaching experience combined with some intuition. After having analyzed our anatomy program quantitatively, we can say that it appears to be very well shaped. Now we have quantitative evidence that our Head and Neck module is not too large (we were wondering about this all the time), even though it takes up 40% of the total teaching time. This module is even larger in TA (47%), even when we excluded the internal features (*Morphologia interna*) of the central nervous system from the analysis since most of these terms are used in our second year subject called "Principles of Neuroscience." A tendency of core medical curriculum toward becoming system-based (3,6) caused a similar swing in anatomy curricula. Academics involved in planning and incorporating system-based changes should not forget important topographic regions that contain small parts of major body systems (eg, head and neck).

In regard to our analysis of textbooks, we noticed that the Introduction module is better represented in the more recent titles. This could be explained by the decreasing number of course hours devoted to anatomy, which makes understanding and accepting general concepts and principles more important than ever, and more recent books support this need. Perhaps in old, much larger, anatomy curricula the Introduction and clarification of general anatomical concepts was a role of the good lecturer, who had the time and opportunity for that.

As pointed out in the results, variations between modules are greater still if clinical anatomy sections are included into the count. In order to remove the "noise" when percentage ratios for modules are proposed, the space/time allocation for textbook/curriculum should be done without taking clinical anatomy into consideration. We propose that, following the division of core material, a decision is made on how much (and which) clinical anatomy text/examples will

be included. Three new textbooks (Clinical Anatomy, Gray's Anatomy for Students, and Clinically Oriented Anatomy) all have a generous percentage of the text related to clinical anatomy, but variations are substantial (16%-30%). AACA recommendations contain 20% of clinically-related terms; perhaps this could be taken as an optimal proportion for the curriculum that is clinically oriented.

Despite relatively large variations between textbooks, all of them correlate significantly with our curriculum. However, this cannot be said for the comparison of textbooks with the AACA recommendations and TA. The organization of only a single textbook showed significant correlation with the AACA recommendation and 2 textbooks correlated with TA. This finding certainly strengthens the importance of the question of what should one use as a guide when planning and creating a topographic anatomy curriculum, or in fact when writing a new anatomy textbook.

In conclusion, there is an obvious disproportion between the "curricular body" and a real human body, which could be painted in the shape of "curricular homunculus," with a rather large head and very small back.

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