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MEDICAL EDUCATION

Influences on Anatomical Knowledge: The Complete Arguments

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Eight factors are claimed to have a negative influence on anatomical knowledge of medical students: (1) teaching by nonmedically qualified teachers, (2) the absence of a core anatomy curriculum, (3) decreased use of dissection as a teaching tool, (4) lack of teaching anatomy in context, (5) integrated curricula (problem-based learning or systems-based curricula), (6) inadequate assessment of anatomical knowledge, (7) decreased anatomy teaching time, and (8) neglect of vertical integration of anatomy teaching. A recent review revealed a lack of evidence underpinning any of the claims owing to the poor quality of papers, and recommendations were made for education and research on teaching in context and the implementation of vertical integration and of assessment strategies. In this article, we will describe the alleged factors fully, revealing additional recommendations for improving anatomy education by promoting recognition for teaching in institutions, by enhancing the professional recognition of anatomists through the implementation of a national postgraduate training program, and by encouraging anatomists to participate in educational research. Clin. Anat. 27:296–303, 2014.

Key words: anatomy teaching; anatomical knowledge; anatomy education; basic sciences; medical education

INTRODUCTION

The role and position of the basic sciences in medical education are under debate (Norman, 2000, 2012; Fincher et al., 2009). Basic sciences are generally defined as the scientific foundations of clinical reasoning and medical practice (Kaufman et al., 2008); a firm foundation of basic science knowledge is considered indispensable for good clinical reasoning, and a sound knowledge of normal structure and function is deemed necessary for a proper understanding of abnormal structure and function (Swanson and Case, 1997). The role of basic sciences in medical education is changing dramatically owing to shifts in educational concepts, for example, from monodisciplinary teaching to integrated learning and from a focus on facts and details to a focus on general principles, mechanisms and concepts (Bergman and de Goeij, 2010).

INFLUENCES ON ANATOMICAL KNOWLEDGE

Although there is no empirical evidence that anatomical knowledge has declined among today's medical students, the claim is persistently emphasized in the literature by authors who attribute it to one or several of the following eight factors (Table 1): (1)

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TABLE 1. Overview of the Factors Claimed to Influence Anatomical Knowledge Among Students Negatively, and the Results of a Literature Review Aimed at Finding Empirical Evidence to Support these Claims (Based on Bergman et al., 2011)

	Factor	Short description	Summary of results of literature review
1.	Anatomy is taught by nonmedically qualified teachers	Anatomy is increasingly taught by staff with nonmedical backgrounds, who may lack insight into the reasons why a subject is taught or why it is relevant from a clinical perspective.	There does seem to be a trend throughout the world for anatomy to be increasingly taught by nonmedically qualified teaching staff. Unfortunately, none of the studies reviewed examined the possible connection between the qualifications of teaching staff and students' knowledge of anatomy.
2.	The absence of a core anatomy curriculum	In order to fit the anatomy curriculum into the available time, in some cases, all aspects of anatomy were pruned, irrespective of vocational relevance. This included deleting specific body regions, embryology and/or histology from the educational program.	There is little agreement on the content of lists of anatomical structures written in the past and the depth of the required knowledge is not specified. Additionally, none of the articles reviewed reported a study investigating (the absence of) a core curriculum and its effect on anatomical knowledge.
3.	Decreased use of dissection as a teaching tool	Anatomy teaching by the time-honored method of cadaveric dissection is decreasing, mostly due to time and/or money constraints.	Results seem to be slightly in favor of dissection, but are not conclusive. However, a combination of teaching tools appeared to yield the best performances.
4.	Anatomy is not taught in context	Anatomy should be taught within relevant contexts, such as clinical skills, pathology, or radiology.	In many studies, students reported more positive attitudes/perceptions in relation to a course teaching anatomy in context than to traditional course formats. However, no study compared the effects on anatomical knowledge of teaching anatomy in and out of context.
5.	Integrated curricula (problem-based learning or systems-based curricula)	In integrated curricula, basic and clinical sciences are taught simultaneously (horizontal integration), with clinical sciences being introduced in the early years while continued attention is paid to basic sciences in the later years of the curriculum (vertical integration). Additionally, many medical schools with integrated curricula have abandoned formal basic science teaching and instead stimulate students to explore these areas through "self-directed learning," supervised by (nonmedical) facilitators. Within these curricula, anatomy is likely to be taught piecemeal, and it is claimed that students no longer gain a coherent, overall picture of the anatomy of the whole body.	Studies that specifically address the influence of PLB and system-based curricula on anatomical knowledge are few. The available evidence, or lack of it, shows that there are no clear benefits or drawbacks of integrated curricula for anatomical knowledge.
6.	The way anatomical knowledge is assessed	For practical reasons, anatomical knowledge is increasingly assessed by multiple choice type questions, wherein good "power-test takers" often do well owing to their ingenuity in eliminating distracter items (Cahill and Leonard 1999). What is also considered alarming is elimination of the requirement for minimal competence in each of the disciplines tested.	Results indicated that the sole use of multiple choice questions and/or the lack of a minimal requirement for each tested discipline indeed have a negative effect on students' behavior and retention of knowledge.

TABLE 1. *Continued*

	Factor	Short description	Summary of results of literature review
7.	Decrease in anatomy teaching time	The multitude of subjects and competencies to be taught in the undergraduate medical curriculum has diminished the amount of time available for anatomy education.	Designated teaching time for anatomy has, in fact, decreased during recent decades. However, no study has investigated the effect of the decreased teaching time on the knowledge attained.
8.	Neglect of vertical integration of anatomy teaching	Vertical integration within curricula is often unidirectional. While clinical topics are integrated in the early years of the medical curriculum (traditionally the time slot for basic science teaching like anatomy), it is perceived to be far less common for basic sciences to be taught in the later years of the curriculum.	Only one study on vertical integration of anatomy teaching is available, but the study methods used preclude conclusions regarding the attribution of the reported improvement in knowledge to vertical integration.

These factors were extracted from 32 articles published after 1990 (29 different first authors, of whom nine held their primary posts in an anatomy department). The articles were published not only in educational, anatomical, surgical, or radiological journals but also in general medical journals such as the British Medical Journal and The Lancet. Most articles were retrieved by a search for keywords in the title, others by scrutinizing references of relevant articles; they were mostly published as editorials, letters/correspondence, commentaries, essays, or matters for debate (Bergman et al., 2011).

teaching by nonmedically qualified teachers, (2) the absence of a core anatomy curriculum, (3) decreased use of dissection as a teaching tool, (4) lack of teaching anatomy in context, (5) integrated curricula (problem-based learning or systems-based curricula), (6) inadequate assessment of anatomical knowledge, (7) decreased anatomy teaching time, and (8) neglect of vertical integration of anatomy teaching. These factors were extracted from 32 articles (29 different first authors, nine of whom held their primary posts in anatomy departments (see Bergman et al., 2011). In 2011, we published a study aimed at finding empirical evidence to verify the influences of the eight factors on medical students' anatomical knowledge. However, the quality of information within the existing literature was insufficient to support any of the claims (Table 1).

Obviously, these factors did not emerge out of the blue. Several authors have cited them as influential and have described their origins. So behind each factor there is a story. Our aim in writing this review is to share these stories with our readers. Since the stories are based on the perceptions and experiences narrated by the authors of the 32 papers we found in the literature, we share them mainly via quotations and anecdotes. When we speak of "the authors," we refer to *them, not to ourselves*. We wish to emphasize that the authors of those papers are responsible for the stories and our narrating them in this review does not imply that we agree with them! However, in this review we want explore the stories fully, as we feel this could lead to important novel recommendations for further research and improvement of anatomy education. We feel there is a lesson in what those 29 authors are telling us, even if we cannot underpin their stories with empirical data (yet)!

Factor 1: Anatomy Is Taught by Nonmedically Qualified Teachers

The authors feel that one explanation for the decline of anatomical knowledge is that it is becoming extremely rare for anatomy to be taught by dedicated, well-trained, medically qualified gross anatomists (Cahill and Leonard, 1999; Older, 2004). It is claimed that anatomy education is provided by faculty whose first interest is research and who look upon teaching as an annoyance, an unwelcome chore, rather than a key responsibility (Fraser, 1991; Halasz, 1999; Monkhouse and Farrell, 1999). The authors argue that this should come as no surprise since faculty are usually recruited for research skills and potential for generating income (research grants), and not to meet teaching needs in particular areas (Cahill and Leonard, 1999; Cahill et al., 2000).

Moreover, the authors state that faculty who are committed to teaching are subverted by the disproportionate importance placed on productivity in research, often measured by the number rather than the quality of research publications a department can list: the university mores of "publish or perish" (Fraser, 1991; Monkhouse and Farrell, 1999). Teaching in both basic and clinical sciences is said to have low priority because, as an academic activity, it is valued less than research (Older, 2004).

Another explanation given by the authors is that teachers who are medically qualified are first and foremost concerned with patient care and not with teaching. Even if they are interested in teaching, they are often restricted by workloads and pressures from a busy clinical service (Halasz, 1999; Raftery, 2006). In some countries, this problem is compounded by a

distinctly unattractive salary structure deterring anyone with clinical qualifications from taking up teaching (Older, 2004).

Halasz (1999) argues that in no other type of professional school is almost half of the curriculum (i.e., the basic sciences) taught by faculty who do not practice the profession they teach. Since nonmedical anatomy teachers are said to have no notion why the subject is taught or why it is relevant from a clinical perspective, the decline in medically qualified anatomy teachers is viewed by the authors as a threat to students' mastery of anatomical knowledge (Monkhouse, 1992; Pabst, 1992; Monkhouse and Farrell, 1999; Older, 2004; Raftery, 2006).

Factor 2: The Absence of a Core Anatomy Curriculum

The authors indicate that the amount of time available for teaching anatomy has fallen during recent decades (see also factor 7) and, in some cases, attempts to fit anatomy within the allocated time have led to all aspects of anatomy (body regions, organ systems, or topics such as embryology) being pruned to a greater or lesser extent, notwithstanding their relevance for the medical profession (Monkhouse, 1992; Cahill et al., 2000; Older, 2004). The authors feel this directly affects the ability of future doctors to practice medicine safely. History-taking, inspection, palpation, percussion, auscultation, imaging, and surgery all require knowledge of how the body is constructed at the cell, tissue, and organ system levels. Looking up anatomical facts and pictures just before a procedure is no substitute for a rigorous knowledge of anatomy (Auer and McDonald, 2003).

In stark contrast to the preceding arguments, clinicians frequently blame anatomists for teaching too many details and not what they define as the anatomical knowledge relevant to medical practice (such as how to provide high-quality care) (Pabst, 1994; Whitcomb, 2006). To explain this criticism, it is argued that the true purpose of undergraduate education has been forgotten: the product of undergraduate medical education is the student trained "to become" a physician (Fraser, 1991; Drake, 1999; Whitcomb, 2006).

The authors claim this problem has arisen because of the absence, or insufficient re-evaluating/re-orientation, of a (national) core anatomy curriculum (Monkhouse, 1992; Halasz, 1999; Older, 2004; Raftery, 2006). Such a core curriculum would cover topics of real clinical relevance and equip students with a good grasp of the relationship between structure and function (Pabst, 1994; Raftery, 2006). If it were in place, teachers (basic science and clinical) would know what their students were expected to learn and would be able to help them attain that knowledge (Bergman et al., 2011).

Factor 3: Decreased Use of Dissection as a Teaching Tool

Curricular reform is thought by the authors to have altered not only the amount of anatomical information imparted to medical students but also the format in which it is presented (Drake, 1999). The authors acknowledge that today's medical students are different. "The world of our students is multimodal and stimulus dependent. [. . .] the greater majority of average students can no longer solely respond to 'cut,' 'read' and 'listen'" (Reidenberg and Laitman, 2002). Expensive anatomy rooms (whether or not for dissection) have been replaced by clinical skills laboratories and computer rooms (or revenue-generating research space) (Monkhouse and Farrell, 1999; Cahill et al., 2000), but what the authors consider most worrying is the increasing decline of anatomy teaching by the time-honored method of cadaveric dissection. They point out that anatomy is now taught via prosections (at best), problem-based tutorials, special study modules (student-selected components), computer-assisted instruction, and plastic models (at worst) (Raftery, 2006). They think that the use of models, images, and audiovisuals fails to provide students with as much anatomical knowledge as comes from the investigative dissection of real tissue. But it is also acknowledged that there are very few substantive data to support this contention (Cahill et al., 2000; Reidenberg and Laitman, 2002; Older, 2004).

Factor 4: Anatomy Is not Taught in Context

Anatomical knowledge among students can, in the opinion of the authors, be enhanced by extending anatomy education to surface anatomy, living (radiological) anatomy, and clinical skills. It is felt that anatomy should be presented in a context of physical examination of patients (e.g., stethoscope, abdominal palpation, peripheral pulses, testing of ligaments, muscle groups, and reflexes) and interpretation of images (e.g. X-rays, CT, MRI, ultrasound, and minimally invasive views through scopes) (Monkhouse, 1992; Pabst, 1992; Reidenberg and Laitman, 2002; Older, 2004; Raftery, 2006). Reidenberg and Laitman (2002) even state that anatomy programs "must be at the forefront of integration of material and a home for interdisciplinary teaching and learning," while Monkhouse (1992) argues that without such integration it is impossible to "see any grounds for the vocational necessity for medical students to study any anatomy." Additionally, the authors suggest that teaching in context can mean using anatomical knowledge to solve clinical problems: "unless students actively apply the concepts they are learning to understanding and explaining clinical problems, the knowledge will remain inert and will be soon forgotten" (Norman, 2007).

Factor 5: Integrated Curricula (Problem-Based Learning or Systems-Based Curricula)

Some medical schools today have largely abandoned the formal teaching of basic medical sciences, leaving students to explore these crucial areas through the problem based learning (PBL) approach alone (Williams and Lau, 2004). The authors fear this

will affect the students' anatomical knowledge in two ways.

First, the authors argue that in some places, self-directed learning has become a mere excuse for staff to abandon their responsibilities to students (Monkhouse and Farrell, 1999). It is also felt that PBL can lead to competent teachers being replaced by facilitators (often anatomically untrained nonmedical scientists; see also factor 1), thereby depriving students of contact with inspirational and knowledgeable mentors, so they acquire less anatomical knowledge (Cahill et al., 2000; Williams and Lau, 2004; Fasel et al., 2005). Second, the authors argue that PBL is an illogical and inefficient way to acquire basic scientific knowledge (Williams and Lau, 2004) because it ignores the fact that the student must simply learn an accepted body of anatomical information; requiring students to gain this knowledge through curiosity and experiment is a waste of valuable time and resources (Monkhouse and Farrell, 1999).

Monkhouse and Farrell (1999) further point to the danger that systems-based teaching can prevent students from gaining a coherent view of the anatomy of the whole body. In systems-based teaching, anatomy is likely to be taught in small segments with no regard to the whole organism, inevitably leaving students with only fragmented knowledge of the discipline. The authors consider it self-evident that doctors should have a sound working knowledge of human anatomy; at the very worst, they will not be disadvantaged by knowledge of the parts of the body, their relationships to another and to the body surface, and how they can be approached safely when intervention is necessary.

Factor 6: The Way Anatomical Knowledge Is Assessed

The authors repeatedly state that anatomical knowledge is assessed inadequately, so it is poorly retained. It is felt that for reasons of practicality, questions on (anatomy) tests are increasingly of the multiple choice variety, in which good "power-test takers" often do well because of their expertise in eliminating distracter items (Cahill and Leonard, 1999; Paalman, 2000; Ellis, 2002; Older, 2004; Raftery, 2006; Turney, 2007). Furthermore, the authors fear the requirement for minimal competence in each of the disciplines tested is being eliminated (Ellis, 2002; Raftery, 2006; Purkayastha et al., 2007): "why should students learn gross anatomy anyway when there are only a few direct anatomy questions on the [USMLE] Step 1 Examination?" (Cahill and Leonard, 1999). "There should be a really tough examination in anatomy and this should be at a very early stage to be certain that candidates know their anatomy before they start practicing on patients" (Raftery, 2006).

Factor 7: Decrease in Anatomy Teaching Time

The authors stated that the explosion of scientific knowledge during recent decades has made the amount of basic scientific information with potential relevance to medical practice too large for instructors to teach or for students to learn. The relevance of basic sciences to clinical medicine is said to be undergoing re-evaluation, inescapable in the face of reduced course hours and the shifting emphases of medical education (Drake, 2002). It is argued that curricular revision to deal with this problem continues to challenge educators in the anatomical sciences at every level (Carmichael et al., 2002). Clearly, choices about which subjects to include in the anatomy curriculum had to be made, but the authors feel that these choices have led to the teaching of either too much or too little anatomy (see Factor 2).

Factor 8: Neglect of Vertical Integration of Anatomy Teaching

Basic science teaching takes up a huge proportion of the preclinical curriculum (Norman, 2007). Unfortunately, although vertical integration is said to help ensure that only clinically valuable basic science is taught (Monkhouse and Farrell, 1999), the authors often experience it as unidirectional. While clinical topics are regularly integrated into the early years of medical curricula (traditionally the time slot for basic science teaching), it is much less common for basic sciences to be taught in later years (traditionally clinical teaching time) (McCrorie, 2000). It is felt that this reform has led to reductions in both the time for (some claim reductions of more than 50% over 25 years) and the content of anatomy education (see also Factors 2 and 7), the most drastic cut being in the laboratory parts of traditional teaching (Cahill and Leonard, 1999; Monkhouse, 1992; Older, 2004). The authors state that undergraduate gross anatomy teaching is in decline worldwide, and it is feared that the pendulum could have swung too far, putting anatomy teaching in danger of disappearing completely from medical education (Fasel et al., 2005; Raftery, 2006). So, neglect of vertical integration of anatomy teaching leads to a decline in gross anatomy teaching, which in turn leads to deficiencies in students' anatomical knowledge. To counteract this, the authors recommend that more anatomy should be integrated throughout the entire medical curriculum (content drawn from the biomedical sciences integrated into the later years of the curriculum) (Beaty, 1990; Older, 2004; Whitcomb, 2006). It is stated that this will also adapt education to the fundamental idea from cognitive psychology that learning consists in the integration of new knowledge into existing knowledge (scaffolding); there is no need to teach everything all at once (Norman, 2007). As Fitzgerald (1992) puts it: "[...] many clinically relevant points have to be omitted from the anatomy course owing to time constraints. The only way out of this dilemma (it seems to me) is by way of vertical integration, whereby clinicians pick up each anatomical ball in turn".

DISCUSSION AND RECOMMENDATIONS

We have described the arguments of different authors that eight factors (listed in Table 1) have

contributed to the decline of anatomical knowledge among medical students. Our 2011 review revealed no empirical evidence to support these claims, and we recommended further research on the implementation of teaching in context, vertical integration, and assessment strategies (Bergman et al., 2011). The following additional recommendations arise from our extensive exploration during the present review of the stories behind the factors. The first and second recommendations—increasing recognition for teaching and enhancing the professional recognition of anatomists—find support from other authors in the recent literature. The third recommendation is more innovative: to encourage anatomists to participate in educational research.

Recognition for Teaching

If teaching received more recognition for its academic value, teachers would have more time and money to invest in the development and/or implementation of: their own anatomical and clinical knowledge and didactic skills (Factor 1), a core anatomy curriculum (Factor 2), different teaching methods (Factor 3), teaching in context (Factor 4), assessment strategies (Factor 6), and vertical integration (Factor 8).

Teaching (anatomy to) medical students is almost invariably combined with research activities for basic scientists or patient care duties (and research tasks) for clinicians (Ten Cate et al., 2011). Medical schools are urged to take their responsibility for preparing medical students to become doctors more seriously (Fraser, 1991). A crucial but unfortunately poorly developed area in most medical schools is human resource management and the rewarding of teaching accomplishments (Bergman and de Goeij, 2010). For academic staff, there is a strong emphasis on research targets, whereas teaching in both basic and clinical sciences is less valued as an academic activity and consequently receives low priority (Older, 2004). Selection for rewards (promotions, space, endowed chairs, etc.) is almost exclusively based on the number of publications and grant funding, not on teaching and clinical competence (Cahill and Leonard, 1999; Fasel et al., 2005).

Teaching needs to be valued, encouraged, and internalized into the culture of the department and institution (Ten Cate et al., 2011). Future developments and improvements in (anatomy) education can only be accomplished by rewarding excellent and enthusiastic teachers and educationalists willing to work to improve the quality of education in their institution (Bergman and de Goeij, 2010). "Teachers should be trained; good teachers should be rewarded, as are productive researchers; and poor teachers should be counseled" (Monkhouse, 1992).

The failure to reward teaching accomplishments could in part be due to failure to recognize the complex skills necessary to succeed as a medical educator. The recent literature contains interesting publications on scholarship in education, focusing on demonstrating scholarship in teaching and other learning-related activities (in contrast to educational research, which can be assessed and rewarded using the same types of evidence as basic science or clinical research) (Turner et al., 2012). In the past, the main criteria for scholarly activities by which institutions evaluated individuals' academic progress were research, peer review of scientific results, and dissemination of new knowledge (Srinivasan et al., 2011; Turner et al., 2012). However, innovation, development, and changes in medical education have entailed a growing appreciation of the importance of the educational mission at a number of medical schools, besides their research and patient care missions (Pawlina and Drake, 2010; Turner et al., 2012). In consequence, broader definitions of scholarship have emerged along with corresponding changes in the respective reward systems (Turner et al., 2012). Teaching can be a scholarly act, but even in many top academic institutions not all teaching is scholarly (Beckman and Cook, 2007). Since a sustained record of scholarship is the foundation for advancement in academia, various initiatives to define criteria for evaluating scholarship in teaching have been published, in order to implement and assess teaching scholars' work (e.g. (Whitcomb, 2003; Moses et al., 2006; Simpson et al., 2007; Fincher et al., 2009; Turner et al., 2012). There seems to be agreement that scholarly teaching must transform and extend students' self-knowledge, be open to the public, be subjected to review, and be accessible for exchange with other educators (Beckman and Cook, 2007). To engage in scholarship for teaching and learning seems a desirable step for anatomists to ensure that the educational product they deliver has quality and is valued by students, institutions, and professional communities (Srinivasan et al., 2011). It goes beyond the scope of this review to discuss the practicalities further, but we would recommend Fincher and colleagues (Turner et al., 2012) and Simpson et al. (2007) as a start for further reading for anyone interested.

Training to Become an Anatomist: Enhancement of Professional Recognition

If becoming an anatomist requires completion of an accredited training program, anatomists as a professional group will gain greater recognition. It is also highly likely that it will inspire a wider range of people to pursue careers in anatomy, especially those whose principal interest lies in teaching. It will also give anatomists a much more solid base for, and therefore improve the quality of, actions and decisions in management, education, and research.

Many countries lack a nationally endorsed training program in anatomy. In the Netherlands, for example, anyone who wishes can call themselves an anatomist. The title is generally used as soon as a position in an anatomy department is acquired. Similar situations obtain in the UK, USA, Australia, and New Zealand. The fact remains that the job title "anatomist" is not founded on an acknowledged professional qualification and consequently carries no regard/prestige or attractive salary structure. Moreover, in the present state of

anatomy education, people with little experience of the subject often have to take action and make decisions in areas that are practically unknown to them.

However, in some countries, the title "anatomist" is only awarded to those who have completed a rigorous training program. In Germany, for example, (veterinary) medical graduates can enter training programs in several institutions to become "medical specialists in anatomy," similar to postgraduate training in surgery or gynecology. For biomedical graduates, the German Anatomical Society offers a program to become a "professional anatomist." These programs cover knowledge of (radiological) anatomy, embryology, and histology, and also body donation and cadaver preservation. They offer skills training in cadaver dissection and histological fixation, cutting and coloring. Completion of training means a rise in salary and a better chance of a permanent position in an anatomy department. However, all the aforementioned training programs focus on participation in biomedical research, showing a general neglect of educational skills.

In the current literature, scant attention is paid to improving the prospects of teachers who wish to pursue a career in anatomy. Results from studies in India and Nigeria show that scarcity of job opportunities and of adequate research facilities make nonclinical teaching specialties such as anatomy far less attractive as career options than clinical specialties (Anand et al., 2004; Onakpoya et al., 2009). It is striking that Indian students interested in becoming anatomists expressed a wish for a formal course in teaching (Anand et al., 2004).

We feel it would be wise for national anatomical associations, in consultation with the anatomy departments of their countries, to set up accredited training programs for anatomists. Such programs should be open to students with degrees in (bio)medical studies. Ideally, training should be part-time, with students holding a position in an anatomy department. Programs should at least focus on increasing students' anatomical knowledge, on skills in dissection and preservation of cadavers, and last but not least, on educational knowledge and skills. Training should also take into account that anatomists work together with medical and biomedical staff in both education and research. If desired, students should be able to train in anatomy while working toward a PhD in the biomedical or educational field.

When there is more recognition for teaching and for the profession of anatomist, anatomy departments will be unlikely to have to hire more faculty who are great researchers but regard teaching as a chore. Also, they will not have to rely on retired clinicians to take up those position as often happens at present, because job advertisements might then attract a significant number of suitable applicants.

Participation in Educational Research

We suggest that each anatomy department should appoint about two anatomy teachers (not educationalists!) who are willing (and enabled) to explore learning theories and principles, keep abreast of the educational literature, participate in/perform educational research, and attend (inter)national educational conferences. By these means, the development and/or implementation of didactic skills, a core anatomy curriculum (Factor 2), different teaching methods (Factor 3), teaching in context (Factor 4), assessment strategies (Factor 6), and vertical integration (Factor 8) can be informed by theory, based on evidence, and subjected to purposeful evaluation.

We want to stress that anatomists should engage in educational research, not that educationalists should take over anatomy education. Some anatomists already feel that ownership of the curriculum has been taken away (hijacked) from the teaching faculty to (or by) the curriculum committee. Subsequently, their decisions on "what is being taught and how" are blamed for influencing the anatomical knowledge of medical students in a negative way.

In medical schools, the anatomy department is usually one of those with the highest teaching load. However, research interests within an anatomy department are more often biomedically than educationally directed. Also, owing to the background of staff and management in an anatomy department, a clear educational strategy is often absent.

For some anatomy departments, teaching is their core business, their "raison d'être," but unfortunately it is not uncommon for anatomy teachers to be frowned upon when they express interest in educational research. This is remarkable: it is self-evident that the regular duties of their counterparts in research and the clinic include reading the latest literature, being oriented toward the latest approaches, developments and theories, replacing existing habits with new ones when appropriate, and submitting their work to critical peer review (van der Vleuten et al., 2000). In medicine, evidence-based practice is widely accepted and has been defined as "[...] the conscientious, explicit and judicious use of current best evidence in making decisions about the care of individual patients" (Sackett et al., 1996). In sharp contrast, Best Evidence Medical Education, defined as "the implementation, by teachers in their practice, of methods and approaches to education based on the best evidence available" (BEME-Group. 2000), is very rarely implemented.

CONCLUSIONS

Despite the absence of empirical evidence, eight factors are often blamed for causing the decline in anatomical knowledge among today's medical students. Since there have been complaints about this decline for decades, we suggest that the perception that anatomical knowledge levels have fallen arises from a generation conflict (Bergman et al., 2011); however, further research is necessary to determine the truth.

Although there are different opinions regarding its scope, there is a general consensus that medical students definitely cannot do without anatomical knowledge, and consequently without anatomy education.

Increasing recognition for teaching accomplishments within an institution, a national training program in anatomy, and dedicated time for anatomists within their departments to involve themselves in the science of teaching, learning, and educational research, could help to identify factors contributing to the acquisition, retention, and transfer of anatomical knowledge and increase the focus on how anatomy education can be made as effective as possible.

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