REVIEW

Perspectives in Medical Education 8. Enhancing Preclinical Education in Japan with a Clinically Focused, Interactive Anatomy Curriculum

Kanchan H. Rao and R. Harsha Rao

University of Pittsburgh School of Medicine, Pennsylvania, USA

(Received for publication on March 13, 2009)
(Accepted for publication on May 21, 2009)

Abstract

Reform of preclinical medical education in Japan requires changes in the curriculum to make it more clinically focused and interactive. At present, course content in Anatomy is usually designed and taught with little or no clinical direction and involves a heavy emphasis on by-rote learning to memorize often minor facts that have little importance in clinical medicine. As a result, the content is boring, it is learned solely for the purpose of passing exams and it is promptly forgotten, with little sense of its need in clinical practice. Successful reform of the curriculum in Anatomy requires two critical changes. The first is that content must be made interesting to students by emphasizing its clinical importance, through a close collaboration between preclinical and clinical departments, Thus, the Surgical Faculty must be incorporated in the organization and teaching of the Anatomy curriculum. Core content can thereby be pared down to only what is considered essential to provide a foundation for the later clinical years, and the clinical importance of that content will, in turn, be self-evident to students. The second change that must be implemented is to make the learning process more appealing to the students. This can be facilitated by the use of any of several commercial IT programs that make learning in Anatomy both dynamic and engaging. These dual strategies will considerably enhance the learning of one of the most basic subjects in the medical school and ensure that the review and retention of the material are enhanced. (Keio J Med 58 (4) : 210–215, December 2009)

***Keywords*: medical education, curriculum reform, anatomy, preclinical training**

Introduction

We have been privileged to be a part of the ongoing effort to reform medical education now underway at Keio University School of Medicine, in Tokyo, Japan. During the first four visits, from 2003 through 2006, one of us (RHR, a clinician-educator with 3 decades of experience) was closely involved in advising the former Dean and the Head of the Department of Medical Education, Professor Takahiro Amano, on how to approach and undertake the task of reforming the medical school curriculum to enhance clinical skills training, in keeping with the mandate established by the Ministry of Health in Japan.[1] The main thrust of the recommendations that emerged, based on observations made during those visits, was to de-emphasize didactic teaching in favor of problem-based learning and the acquisition of clinical skills.[2–5] This set in motion a process that, as noted earlier, is more-or-less a recapitulation of the process that played out in the late 80's and early 90's in medical schools across the US.[6–8]

Once the need for such reform was acknowledged at Keio, the next logical step in the progression towards an integrated curriculum at Keio was to reform the preclini-

Presented at the 1575th meeting of The Keio Medical Society in Tokyo, July 14, 2008.
Reprint requests to: Kanchan H. Rao, MD, Office of Admissions, University of Pittsburgh School of Medicine, 518 Scaife Hall, Pittsburgh, PA 15261, USA, Tel: +1-412-648-9891, E-mail: kangan13@yahoo.com

cal curriculum to serve the needs of this overall goal. To this end, the authorities at Keio saw fit in 2006 to also seek the advice of the other author of this paper (KHR), a medical educator in Anatomy with experience in the implementation of an integrated and interactive preclinical curriculum at the University of Pittsburgh. Even on that first visit, the tremendous effort that was being made to introduce an integrated and problem-based curriculum at Keio was quite remarkable. It was obvious to us that an excellent start had been made in conceptualizing the curriculum and beginning the difficult and complicated task of developing it, and we felt privileged to provide our input into that effort, based on KHR's prior experience with the introduction of an integrated, problem-based Anatomy curriculum at the University of Pittsburgh.

During that prior visit in 2006, we met a number of the faculty and discussed the pedagogical details with regard to introducing PBL in Anatomy and various ways of highlighting the clinical relevance of the subject. KHR also conducted an Anatomy PBL, and her experience confirmed earlier observations that, even in this preclinical area, the students of Keio University School of Medicine found this method of "active learning" far more interesting and exciting than the "passive learning" that they are used to in a traditional curriculum with its heavy emphasis on didactic teaching and by-rote learning. The report of that visit was the subject of a previous paper in this series, and the reader is referred to that for details of our observations and specific recommendations.[9]

With this as the background, we returned to Keio in July 2008, having been invited by Professor Amano with the specific purpose of facilitating the further implementation of an integrated Anatomy curriculum. This paper is based on an address made to the Keio Medical Society during that visit, and the main points form the basis of our report to Professor Amano of that visit.

Within the overall context of making specific recommendations on how to reform the Anatomy curriculum to make it more interesting and interactive, there were two specific goals of our visit. The first goal was to provide advice on how exactly to develop a clinical focus to the teaching of anatomy, and how to incorporate clinical material in Anatomy curriculum. In addition to this objective of developing and strengthening the clinical focus of the anatomy curriculum, the second objective of the visit was to advise the Curriculum Committee on the incorporation of Information Technology in the teaching of anatomy in order to enhance the Teaching/Learning Experience.

OBJECTIVE I
To Shift the Focus of the Anatomy Curriculum so that It Serves a Future Clinical Need

There are several elements that go into the effort to incorporate clinical material into the anatomy curriculum. Of these, the following are the ones that are, in our view, the most important from the point of view of what is most easily achievable at Keio University School of Medicine, and in the context of the strengths that we have observed among the faculty:

1. Develop a Multi- and Inter-disciplinary Approach to Teaching Anatomy

An inter-disciplinary approach to teaching anatomy and all the other pre-clinical disciplines has been recommended as a way to increase interest level in these subjects.[10,11] Our experience at the University of Pittsburgh School of Medicine following the implementation of an integrated curriculum in the early part of 1992 showed that the interest level of students in studying Anatomy increased substantially when the clinical relevance of the material was highlighted by clinicians' participation in the course. This was achieved by involving Surgeons, Radiologists, Neurologists, Gynecologists and Urologists as teaching faculty in the Anatomy course. Their participation included helping students in the Dissection Laboratory, and facilitating the Problem Based Sessions in Anatomy. Surgery residents were also encouraged to assist in the laboratory as it would help them to review their knowledge of the subject while helping the students in their dissections. Following the dissection of each anatomical region, Radiologists taught the students the basics of reading X Rays, CT Scans and MRI scans. The lesson to take from this experience is that the inclusion of clinical faculty in the teaching of Anatomy is essential for the success of the integrated curriculum.

2. Establish and Maintain a Collaborative Dialogue between the Departments of Anatomy and Surgery

It was most heartening and encouraging for us to observe the willingness on the part of the faculty members in both the Department of Anatomy and the Department of Surgery to engage in a collaborative dialogue. The importance of establishing such a collaborative dialogue between the two Departments was recognized by the Curriculum Committee at Keio, under whose auspices a meeting was convened during our visit, which was chaired by Dr. Takahiro Amano and attended by the Anatomy and the Surgery faculty. Even though the conversation was in Japanese, which neither of us speaks or understands, it was obvious to us that both departments take very seriously their shared responsibility to teach the subject in such a way that the students understand the

clinical application of this basic science subject. We could sense that the faculty members were truly engaged in the process of conceptualizing and developing the new medical school curriculum.

This attitude of constructive engagement across disciplines is a critical aspect of introducing an integrated curriculum at Keio University Medical School, and of all the collaborations that are called for in such a curriculum, there is none more important than the integration of Anatomy and Surgery in the curriculum. This is particularly because the future direction and success of the integrated curriculum as a whole can be derived from the manner in which Anatomy is taught. Anatomy is the very basis of Medicine and it is usually the first course that is taught in most medical school curricula. In addition to learning the structure of the human body, medical students learn medical terminology, learn to work with a diverse group of peers in the dissection laboratory and come to understand human mortality, perhaps for the first time. All of these make the teaching of Anatomy a unique opportunity to set the tone for the entire curriculum.

3. Reinforce the Clinical Relevance of Anatomy by Facilitating Direct Patient Contact with the Students

One of the most interesting ways to heighten student interest in a preclinical subject in the first year of medical school, such as anatomy, is to organize a Patient-Doctor Seminar as part of the course. It is possible to illustrate the importance of using interactive live patient seminars to enhance the learning experience in Anatomy using our own experience at the University of Pittsburgh. During the Anatomy course there, when the students finish studying the Thorax, for example, a Thoracic surgeon brings in a patient on whom he has performed a heart transplant. The entire class of 145 students observes the surgeon recount the history, signs and symptoms of the patient before the operation was performed. The patient then discusses his medical problem with the class and answers any questions posed by the students. The surgeon then reviews the anatomy of the heart and shows the students a video of the surgical procedure, after which the patient describes the change in the status of his/her health and lifestyle following the operation. The students enjoy this segment very much as they are able to understand the clinical application of Anatomy, and also because they are able to interact with a patient in manner that validates the importance of the subject they are studying.

4. De-emphasizing Didactic Teaching

It should become obvious from the foregoing discussion that lecturing is just one aspect of teaching. Lectures are important to convey difficult concepts and to teach students those areas of the subject that are difficult to dissect. The most relevant and valuable teaching of the subject is done in the Anatomy dissection hall. Hence, this is where clinicians, especially surgeons can contribute the most. It is impossible to overemphasize the importance of involving surgeons in the teaching of Anatomy. This is because surgeons are able to provide students with an immediate perspective on the practical importance of the material they are learning. One of the most valuable resources we were able to mobilize is surgeons who have retired. They enjoy teaching young students and the students are excited to learn from people who have spent an entire lifetime using their knowledge of Anatomy in treating patients.

5. Re-emphasizing Anatomical Concepts in the Clinical Curriculum

In a traditional curriculum, anatomy is taught at entry and is never revisited after the course is finished. This not only conveys the impression to the student that material learned in that course does not have direct applicability to clinical material in later years, it also assures that little of whatever is learned is remembered in those years. Thus, it becomes important that an integrated curriculum should not only incorporate clinical material in the anatomy course, it should equally incorporate anatomical material in clinical courses. To this end, the curriculum should be organized so that students are made to review their knowledge of Anatomy on multiple occasions during their tenure in medical school following their Anatomy course. This is achieved by reinforcing and reviewing Anatomy at the beginning of each Organ system/Block. Anatomical study aids like plastinated specimens, preserved specimens, models and prosected specimens are useful for this purpose.

6. Set up a Surgical Anatomy Course in the Later Years of Medical School for Students Interested in a Career in Surgery

At the University of Pittsburgh School of Medicine, the curriculum includes a Course in Surgical Anatomy. It is offered in the final year of medical school, after the students have made their career choice of specialty. Those students who have chosen Surgery as their specialty enroll in this course. It is planned, implemented and taught by Surgeons. They lecture on surgical techniques and procedures following which they demonstrate these techniques on cadavers. The students who are interested in reviewing basic anatomy are permitted to do so. In the context of the curriculum at Keio, a Surgical Anatomy course could be offered at the appropriate time during the Surgical Residency and the Emergency Medicine Residency.

7. Incorporating Medical Imaging into the Teaching of Three-dimensional Anatomy

Medical Imaging plays a very prominent role in clinical medicine, regardless of specialty, so that its importance in the medical curriculum must not be underestimated.[12–14] The tremendous advances in this field make it imperative that anatomy be understood in the context of these imaging modalities, so that the interpretation of these two-dimensional images in clinical medicine can then be related to the three dimensional anatomy that has been learned on the cadaver in the dissection hall.

The incorporation of imaging technology in the teaching of body structure can immeasurably enhance the learning of Anatomy. Techniques such as Ultrasound, CT, and MRI enable medical students to study the human body in an entirely new way that is both exciting and interesting, because it shows them the clinical relevance of anatomy in a way that is both visual and immediate. Thus, combining the comprehensive study of relevant CT Scans and MRIs with simultaneous dissection establishes the clinical relevance of the subject. This is the key to the success of the new integrated and problem-based curriculum at the University of Pittsburgh: students study Anatomy with greater interest and retain the material for longer periods of time because its clinical relevance is established for them.

8. Use Information Technology to Make Anatomy Learning Interactive

A key element to making an integrated Anatomy curriculum even more interactive and interesting could be the use of Information Technology to enhance the learning experience for students.[11] Although these modalities were not a part of the Integrated curriculum introduced at Pittsburgh in 1992 (for the simple reason that these programs have only become available in the recent past), they could prove to be of great value specifically in the Japanese context.

Several excellent Information Technology programs (IT Programs) are available and these could be made available to students through the Intranet at Keio University School of Medicine. They are particularly useful when students are in their Medical Student Clinical Rotations in their 5th and 6th years of medical school (particularly the Surgery and Emergency Room rotations). A review of Anatomy using these advanced IT Programs would make the time spent in the clinical setting a far more valuable experience. Another IT option that is now available for incorporation into an Integrated Anatomy curriculum is the use of simulations of the dissection of the human body. These options are discussed in the following section, because the use of these IT tools for teaching Anatomy was the other declared focus of this visit to Keio University School of Medicine.

OBJECTIVE II
The Use of Information Technology Programs to Enhance the Teaching and Learning of Anatomy

There are a number of computer-based and internet-based programs that are available in the market today. I would like to state at the outset that these programs, however sophisticated, should be used as an "adjunct" to dissection and not as a primary tool of learning.

Review of several IT programs for Anatomy reveals that there are 3 programs that could prove to be beneficial to students at Keio University. All the programs have interesting and innovative features. These programs are:

1. ADAM (Animated Dissection of Anatomy in Medicine) Interactive Anatomy

This is a software program that makes it possible for the student to digitally "dissect" the human body layer by layer, and thus can be used as a companion teaching tool with cadaveric dissection.[15] It is divided into five sections, as follows:

a) Dissectable Anatomy: In this section, the students are able to peel off each layer of the body starting from the skin and going to the deepest organs in the body and can therefore visualize the relationship of structures to one another and to the body as a whole. In addition, anatomical structures can be labeled and each structure/organ can be "extracted" in order to study it in isolation from the rest of the body. It is also possible to rotate the body so as to be able to view a particular structure/organ from the anterior, lateral and posterior aspects.
b) The Anatomy Atlas: This section is good but, by itself, it does not compare as a stand-alone Anatomy learning tool with the online edition of Netter's Atlas of Anatomy by Frank Netter. In combination with the first section ("Dissectible Anatomy") however, The "Anatomy Atlas" is a valuable tool, particularly because of the inclusion of Radiographs in this section of ADAM. This makes the program quite useful for students both prior to dissection and subsequently to review the material learned in the dissection lab.
c) The 3D Models: This part of the program provides the viewer with views of the heart, lungs, skull, brain, ear, eye and the male and female reproductive organs. The "blown up skull" is a particularly interesting aspect of the skull model because it allows the student to visualize the individual bones of the skull as they relate to each other, which is otherwise very difficult for the student to conceptualize.
d) The Clinical Illustrations section includes diagrams with a brief explanation of the clinical condition that they depict. As stated earlier, if medical students are taught the clinical relevance of the basic science sub-

ject that they are studying, their attitude towards learning changes for the better. The following 2 sections serve this purpose. Some examples are: Internal fixation of a fracture, Lithotripsy procedure, Epidural injection site, Coarctation of the Aorta, Graves' Disease and Insulin Pump.

e) The Clinical Animations section is by far the most interesting aspect of ADAM, because it makes the surgical application of anatomical knowledge a reality for the student, and thus brings the subject "to life". A step-by-step narration accompanies a series of animations that depict procedures such as a Coronary Artery Bypass Graft (CABG) and a Directional Coronary Atherectomy (DCA).

2. Primal Pictures

This is a web based resource of exceptional picture quality.[16]

- The visual excellence of this program is particularly evident in the Models and Dissections. Students can get a good grasp of the layers in which the body is arranged, much as they would in the ADAM program, but the images are of a much superior quality in Primal Pictures.
- A very interesting feature is the section on Clinical Pathology, in which the clinico-pathologic correlates of the anatomic structures on display are described. This is a welcome feature of the program because it emphasizes the clinical relevance of Anatomy.
- Students are able to visualize complex anatomic relationships by rotating a model on the screen through 360 degrees, while they peel off layer by layer to visualize deeper structures that are hidden by superficial ones. This feature is especially valuable in depicting a constricted space like the pelvis.
- The Program also has a very interesting feature of muscle action. The muscle groups (agonists and antagonists are shown in "different colors" as they contract and relax during specific joint movements. The importance of this feature for the understanding of kinesiology is self-evident.

3. Touch of Life

This is a very useful program as it helps students to correlate cross-sectional anatomy with particular planes of the body, which in turn helps them to understand CT scans and MRIs.[17] A necessary pre-requisite, therefore, is that the students have a basic understanding of the 3-dimensional relationship of the organs and structures in the body before viewing this program. Hence this is a more advanced program and would be very useful for reviewing Anatomy during the Organ/System blocks and during the Clinical Rotations. The program allows the student to simultaneously view (on a split screen) the level of a particular section on the body and the actual cross section. Thus, by scrolling up or down, it is possible to change the levels of the cross section and observe the appearance and disappearance of various organs and structures. All the relevant and important structures in the cross section are labeled. This is also a very good learning tool for clinicians interested in learning radiologic anatomy.

4. Virtual Reality

Highly advanced virtual reality technology is being used to create learning tools for medical education, including Anatomy.[18] At present, each institution is developing its own programs and it is possible that these will become available commercially in the future.

Conclusions

The tremendous progress being made at Keio University School of Medicine in developing and implementing an Integrated Curriculum has impressed us. The enthusiasm for reform and the commitment to completing the difficult task are palpable to us. In particular, the determination to forge ahead with introducing real change is evident in the manner in which the authorities are approaching the wholesale revamping of the curriculum to make it more clinically focused and to engage the students through the incorporation of interactive technologies. Nowhere is this better demonstrated than in the approach that is being taken to change the Anatomy curriculum. Our observations will, we hope, help the faculty of the departments of Anatomy and Surgery in furthering their collaborative effort to develop and organize the Medical Anatomy curriculum. We feel privileged and honored to be part of that effort, and hope that our recommendations, which derive from personal involvement in the successful implementation of an Integrated Curriculum at the University of Pittsburgh, will prove to be useful in facilitating the cause of reform at Keio University Medical School.

References

1. Report of the Coordinating Council on Medical Education: Measures for Reform of Medical and Dental Education-Toward Reconstruction of Departmental Education. Ministry of Health, Japan, March 27, 2001
2. Rao RH: Perspectives in medical education 1. Reflections on the state of medical education in Japan. Keio J Med 2006; **55**: 45–55
3. Rao RH: Perspectives in medical education 2. A blueprint for reform of medical education in Japan. Keio J Med 2006; **55**: 81–95
4. Rao RH: Perspectives in medical education 3. Reforming medical education to change healthcare practice in Japan. Keio J Med 2006; **55**: 141–148
5. Rao RH: Perspectives in medical education 4. A "global" dimen-

sion to reform at Keio University. Keio J Med 2007; **56**: 1–12
6. 82nd Annual Report on Medical Education in the US, 1981–1982. Future directions for medical education. JAMA 1982, **248**: 3225–3239
7. Muller S, *et al*: Project panel on the general professional education of the physician and college preparation for medicine: physicians of the twenty-first century. J Med Educ 1984; **59** (Suppl): 1–208
8. Committee on Medical Education, the New York Academy of Medicine. Symposium on the training of tomorrow's physicians: how well are we meeting society's expectations? Bull N Y Acad Med 1984; **60**: 219–308
9. Rao RH: Perspectives in medical education 5. Implementing a More Integrated, Interactive and Interesting Curriculum to Improve Japanese Medical Education. Keio J Med 2007; **56**: 75–84
10. Branch WT, *et al*: Teaching medicine as a human experience: a patient-doctor relationship course for faculty and first-year medical students. Ann Intern Med 1991; **114**: 482–489
11. Bloom SW: Structure and ideology in medical education: An analysis of resistance to change. J Health Soc Behav 1988; **29**: 294–306
12. Erkonen WE, *et al*: Gross anatomy instruction with diagnostic imaging. Invest Radiol 1990; **25**: 292–294
13. Erkonen WE, *et al*: Effectiveness of teaching radiologic image interpretation in gross anatomy. A long-term follow-up. Invest Radiol 1992; **27**: 264–266
14. Miles KA: Diagnostic imaging in undergraduate medical education: an expanding role. Clin Radiol 2005; **60**: 742–745
15. A.D.A.M http://www.adam.com/aia/demo/index.html
16. Primal Pictures http://www.primalpictures.com/Home.aspx
17. Touch of Life http://www.toltech.net/products/vh_dissector/video.htm
18. Nieder GL, Scott JN, Anderson MD: Using QuickTime virtual reality objects in computer-assisted instruction of gross anatomy: *Yorick - the VR Skull*. Clin Anat 2000; **13**: 287–293