

Association of Remedial Tutorial to Students at Risk of Failing Anatomy and Their Improved Performance

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ABSTRACT

The purpose of this study is to evaluate the effectiveness of a structured, interactive remedial tutorial intervention program for at risk students. During the period studied, between 10 and 20% of the first year students failed the unit 1 gross and developmental anatomy examination. These students were provided with a highly structured series of weekly interactive remedial tutorials (3-4 hours each for 13 weeks) that specifically involved the application of factual knowledge to clinical problem solving. Their performances on subsequent departmental and National Board of Medical Examiners (NBME) subject examinations were evaluated. By developing a remedial tutorial program in an interactive small group format with specific goals the at-risk students built confidence and acquired the cognitive ability to solve clinical problems. As a result, they successfully completed the anatomy course. Data collected from the last five years firmly supports the concept that, independent of a student's prior experience, consistent practice with problem solving enables successful completion of the first year course.

INTRODUCTION

In 1984, the Association of American Medical Colleges (AAMC) recommended curriculum changes at all traditional medical schools toward problem-based, student-centered learning with an integration of basic and clinical sciences.^{1,2} Preclinical curricula in medical schools across the country have continued to move away from the teacher-centered and discipline-based curriculum to an integrated student-centered model. The changes involved reduction in lecture hours (learning discrete facts) with more emphasis on teaching concepts and principles to help students develop problem-solving skills.

The Gross and Developmental Anatomy course at New Jersey Medical School (NJMS) is a highly clinically correlated course. Thus, students need basic cognitive skills in knowledge acquisition and interpretation, coupled with problem identification and clinical reasoning to perform well. Students enter our first-year, first-semester course with a variable range of problem solving skills. When confronted with a rigorous course in anatomy during the early part of medical school, the task of acquiring a highly detailed knowledge base is often a challenge. The ability to apply this information during analysis of clinical problems also varies among students. In gross and developmental anatomy, students are no longer assessed on their ability to recall isolated pieces of information. Instead, examinations include objective and structured multiple choice questions (MCQ) with clinical vignettes that are designed to test problem-solving skills. The purpose of this study is to evaluate the effectiveness of a structured, interactive remedial

tutorial intervention program on subsequent performances of at-risk students in the gross anatomy course. Specifically, a performance-based method that is used in the gross anatomy course at NJMS is described.

MATERIALS AND METHODS

The study involved students who failed their first unit written anatomy examination, which was given five-weeks into the course. Students who received scores below the passing grade of 70% were considered to be 'at-risk'. Approximately 65 % of the course time was spent in cadaver dissection with four students assigned to each cadaver. The laboratory instructors routinely stressed clinical application of anatomical knowledge, and attendance in the laboratory was mandatory. The course was taught by ten experienced faculty and the information presented was uniform in each laboratory. In addition to anatomy, students concurrently studied physiology and psychiatry and two one-half day periods were available each week for unstructured activity. Table 1 serves to summarize content and time allotted for each unit of the gross anatomy course. The developmental anatomy material that pertained to each unit was presented during structured, clinically oriented lectures, and this material was included in the written examinations. The average GPA and MCAT scores were comparable for the classes (GPA 3.48 ± 0.06 ; MCAT 30.05 ± 0.4) evaluated in this study.

At the end of each unit, students were required to take a practical laboratory examination and a written examination that consisted of multiple-choice questions (MCQ). Each unit

Table 1. Content and time allotted for each unit of the course.

	Unit 1	Unit 2	Unit 3
Content	Thorax Back Upper extremity	Head Neck	Abdomen Pelvis Perineum Lower extremity
Allotted time	5 weeks	4 weeks	6 weeks
Course hours	73	49	57

written examination typically contained 120 MCQ's. A major proportion of the questions were in the form of clinical vignettes that were developed for the content of each unit (Appendix 1). The time allotted to complete each unit written examination was 2 hours and 30 minutes. Students were not permitted to keep the examination booklets, but were allowed to review the questions in a supervised setting after their grades were posted. For each unit practical examination, students were required to identify 50 structures on the cadaver. The NBME subject examination was used as a comprehensive final.

Each student who failed the unit-1 written examination received a letter directing them to attend a structured tutorial program. All students, considered at-risk, attended these tutorial sessions, which were interactive and based on problem solving. Prior to such structured tutorial sessions (before 1997), students who failed the unit-1 examination were tutored either by the graduate students or upper class medical students. These

tutorials were arranged through the Office of the Academic Development, and the anatomy department played no role in directing the tutors.

The structured tutorial program consisted of one, 2-3 hour session each week for the remainder of the semester. An additional hour of tutorial was conducted in the laboratory. Students were required to study the weekly material prior to each tutorial session and during the tutorial, they were taught to apply this knowledge to analyzing and solving clinical problems. By requiring student preparation before each session, a sense of shared responsibility between the students and faculty was established. During the past three-years, problems discussed during these interactive sessions have included pathophysiology to expand the students' thinking process. We also incorporated MCQ's that tested basic anatomical knowledge.

During each session, approximately 10-15 problems were discussed in an interactive format (Appendix 2). The author facilitated these interactive sessions and ensured active participation by all the students. 'Backward' reasoning, i.e. working from clinical information back to theory when problem solving, sharpened their analytical skills. Students' performances on units-2 and units-3 and the NBME subject examination were evaluated to test the benefit of the structured tutorial sessions.

RESULTS AND DISCUSSION

The premise for this study was that early identification of first year students who were at risk of failing gross anatomy provided a basis for intervention with remedial tutorial programs. We hypothesized that failure of the first gross anatomy examination, given five-weeks into the program, was

Table 2. Number of students who scored below the passing grade in each unit examination.

Year	% of Clinical Questions	Unit 1	Unit 2	Unit 3	Final	Course*
1997 (S)	25	7	1	31	57	4
1998 (S)	45	14	4	19	29	2
1999 (S)	75	33	8	15	6	4
1999 (F)	90	35	8	13	7	6
2000 (F)	90	35	11	7	1	3

S= Spring & F= Fall semester. Passing grade = 70. Final = NBME subject examination.

* Number of students who failed the course, and their status are shown below.

Year	Left the school	Repeated the year	Passed summer examination
1997 (S)	1	2	1
1998 (S)	-	1	1
1999 (S)	2	11	
1999 (F)	-	4	2
2000 (F)	-	2	1

Table 3. Class performance- average grade for the Academic year 1997 through 2000.

Academic Year	% of clinical questions	Grade in Percent*				
		Unit 1	Unit 2	Unit 3	Class course average	NBME
1997	25	85±8.2	82±6.4	79±9.7	82±8.1	73±6.8
1998	45	80±8.2	84±6.8	77±8.8	81±7.9	77±7.3
1999 (S)	75	78±9.0	84±6.8	79±7.4	80±7.9	81±7.0
1999 (F)	90	77±9.8	85±7.5	85±7.5	82±8.3	84±7.9
2000 (F)	90	76±9.5	82±8.9	82±9.1	80±9.2	83±6.5

* Indicates class average for the unit examination. Class course average: Indicates aggregated class course average for the year. NBME: Examination score provided by the NBME.

a reasonable warning of further academic difficulty. The class size for each academic year included in the study was between 171-176 students. In 1997, seven students (4% of the class) failed the unit-1 examination. However, while most (6.5%) improved their test score on unit-2, four students (more than half the students who were considered at risk) failed the course. In 1998, fourteen students (8% of the class) failed the unit-1 examination. Ten of them improved their performance on the unit-2 examination, and two of the original 14 failed the course. In years 1999 and 2000, 20% of the class (35 students) failed the unit-1 examination, which was greater than the previous years. Following the tutorial, approximately 65-75% of the failing students, improved their performance in units-2 and unit-3 and scored above the passing grade.

The number of students failing the unit-1 examination increased steadily from 4% in 1997 to 20% in the year 1999 and 2000. As shown in Table 2, proportions of the MCQ with clinical vignettes also increased from 25% in 1997 to 90% in 2000. These clinical questions required analytical interpretation and problem solving. In the Fall 2000 course only seven of the 35 students who failed the unit-1 examination did not show improvement on subsequent examinations. Table 2 indicates that more students performed poorly on unit-3 than the unit-2 examination. During the last few weeks of the anatomy course, the students also took final examinations in other concurrent courses, and this seemed to adversely affect their performance in anatomy.

Average grades for the course's unit examinations are shown in Table 3. The class average for unit-1 steadily decreased from 85% in 1997 to 76% in 2000. On the contrary, the class average for unit-3 examination showed an improved performance during the same years. When the proportion of clinical questions was increased in the unit-1 examination, the number of students who failed this unit was also increased. However, after the students were assisted in learning to apply factual information to the clinically correlated questions in the subsequent 13-weeks of the course, their performances on unit-2 and unit-3 were improved. Moreover, incorporation of clinical correlations in the day-to-day teaching and in the unit examinations substantially increased the performances of all

students on the NBME subject test, which served as the comprehensive final (Table 3).

In the last five classes three students left the medical school while eight students, due to multiple subject failures, repeated the first year (Table 3). Those students who had failed only anatomy was given a NBME subject test as make up summer examination. All students who took the make up examination passed and were promoted to the second year.

Table 4 presents average grades for the course's unit and final examinations for the students who failed the course, prior to instituting the remedial tutorial program. I contend that had there been a remedial tutorial program, most of these students would have successfully completed the course. In support of this contention, I would suggest that the tutorial program, as indicated by students in the course evaluation, helped to redirect the learning approach, that is, applying discrete facts to problem solving encouraged the students to synthesize and integrate anatomical concepts. Secondly, the interactive nature of the tutorials enabled open discussion among the students that resulted in collective thinking to reach the right answer, and thereby solve the problem posed. During the fall semester of 2002, the tutorial program was discontinued, and the students worked extra hours on their own. This self-directed approach resulted in 11 failures for the course. Of the 11 failing students, at least seven could have been helped had there been a tutorial program. Looking at the data from 1995 and 1996, which were pre-tutorial, and the data from 2002, when the tutorial was discontinued, I strongly feel that the tutorial program was helpful in redirecting the students approach to learning, which then led to their success in the course.

CONCLUSIONS

Students at-risk for failing gross anatomy, when placed in a structured remedial tutorial program, were successful in ultimately passing the course. The key to this success was initially delegating the responsibility of learning to the students and subsequently facilitating the interactive group process where gained knowledge was applied to clinical problem solving.

Table 4. Course performance of students who failed Gross Anatomy prior to instituting the tutorial program.

STUDENT	UNIT 1	UNIT 2	UNIT 3	FINAL
Academic year: 1995				
1.	57	64	56	63
2.	61	65	53	63
3.	66	58	66	61
4.	55	49	51	48
5.	63	57	69	63
6.	65	56	65	60
7.	64	63	63	66
8.	49	55	57	60
9.	60	66	61	62
10.	55	51	60	49
11.	63	59	48	63
12.	60	54	63	62
13.	66	52	62	62
14.	63	59	43	62
Academic Year 1996				
1	65	59	60	69
2	43	50	50	46
3	63	47	60	60
4	65	63	64	68
5	63	64	64	55
6	63	57	61	67
7	63	60	64	71
8	65	63	61	65
9	58	59	64	64
10	62	65	59	61
11	58	62	58	68
12	53	49	51	62

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APPENDIX 1

Questions used in MCQ's

CASE (1): A patient complained of tiring easily, and shortness of breath on exertion. Auscultation of the chest showed a diastolic heart murmur heard best at the apex of the heart, and the presence of a collapsing pulse (forcible pulse that rapidly diminishes).

Question: In the above patient, which one of the following conditions explains the 'collapsing pulse'?

- A. Disease of the tricuspid valves.
- B. Disease of the bicuspid valves.
- C. Aortic insufficiency.
- D. Coarctation of the aorta.
- E. SA node problem.

Answer: C

CASE (2): After minimal exertion a 10-year-old child complains of tiring easily and shortness of breath (SOB). Auscultation of the chest showed a continuous machinery like murmur left of the sternum between the first and second intercostal space. At the time of SOB, analysis of the arterial blood oxygen level is slightly elevated in the right radial artery compared to that sampled from the left femoral artery. Chest X-ray showed a dilated pulmonary artery.

Question: Which one of the following conditions explains the child's problem?

- A. Patent ductus arteriosus.
- B. Patent foramen ovale.
- C. Pulmonary artery stenosis.
- D. Aortic valve stenosis.
- E. Coarctation of the aorta.

Answer: A

APPENDIX 2

Interactive tutorial sessions

CASE (1): A 27- year-old female complains of progressively worsening shortness of breath while playing tennis.

History of present illness: Increasingly fatigue over the past several months with recurring palpitation (what is it?).

Physical exam: Heart rate 130 (Is this normal ? If not, Clinically, what is it called?), BP 85/58 (Is this normal? If not, Clinically, what is it called?), No Cyanosis (What is it?), left parasternal heave (Why?), mid-systolic ejection murmur in the pulmonary area, (Why?), unusually louder mid-diastolic rumble heard in the 4th ICS at the left sternal border (Why?), systolic flow murmur at lower left sternal border.

Labs: Right ventricular hypertrophy (RVH), increased oxygen saturation between the SVC and right ventricle.

Imaging: Increased pulmonary vascularity (Why?), dilated pulmonary artery (Why?), Right atrium and ventricle enlarged (Why?), small aortic knob (Why?).

What is your diagnosis? (Atrial Septal Defect)

Answer all the questions.

CASE (2): A 29-year-old male complains of fatigue easily, persistent headache and epistaxis (What is it?).

History of present illness: Dyspnea on exertion, palpitation, claudication (What is it?) and occasional dizziness.

Physical exam: Normal respiratory rate (how many?), BP in arms 195/90, leg 90/65, delayed and weak femoral pulse compared to radial pulse. (Why?), no cyanosis. Chest exam- harsh, late systolic ejection murmur heard in the interscapular area of the back , bilateral palpable intercostal pulse (Why?).

Labs & Imaging: Chest X-ray- suggests LVH (Why?), rib notching (Why?), enlarged aortic knob (Why?).

What is your diagnosis? (Coarctation of the aorta)

Also answer all the questions.