

2003

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### Recommended Citation

Forester J, Cole M, Thomas PP, McWhorter D. Introducing Critical Appraisal of Biomedical Literature to First-Year Medical Students in Histology. *Journal of the International Association of Medical Science Educators*. 2003; 13(1).

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# Introducing Critical Appraisal of Biomedical Literature to First-year Medical Students in Histology

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## ABSTRACT

During the preclinical phase of medical school, most students rely on instructor-provided lecture notes and required textbooks, and note taking during lectures. By the time medical students begin their clinical clerkships, they are accustomed to accepting the word of authority at face value. Paradoxically, physicians must be able to critically evaluate and solve patient problems from a rapidly expanding body of biomedical literature. To address this discrepancy and to help show the relevance of histology to medicine, we implemented a program to introduce critical reading of biomedical literature throughout our 21-week histology course. During weeks one through four, students in the class of 2003 (N = 224) were randomly divided into 56 groups (n = 4) and taught how to conduct a MEDLINE search. Groups were required to submit a biomedical publication abstract from their MEDLINE search that contained histological and clinical elements by week eight. Subsequently, students attended two 60-minute critical appraisal seminars. By week 15, groups submitted a one-page summary of their selected journal publication and answered a set of critical appraisal questions. During weeks 16-19, students prepared a four-minute oral presentation. Three years later, these students were asked to assess the value of our critical appraisal program. Most respondents agreed and strongly agreed (96.1%) that the time needed to complete Critical Appraisal program was manageable. Nearly three-quarters of the respondents (74.5%) agreed and strongly agreed that the Critical Appraisal program demonstrated the relevance of histology to medicine, helped in other courses, and fostered collegiality among classmates. More than four-fifths of respondents (86.3%) agreed and strongly agreed that the Critical appraisal program was worth the effort. The critical appraisal program described herein is a resource-efficient method for introducing critical appraisal of biomedical literature to first-year medical students within the context of a first-year basic science course.

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## INTRODUCTION

As a result of biomedical research and technological advancement, physicians are continuously inundated with new information about preventive measures, diagnostic tests and treatments that will improve the quality of patient care. Consequently, physicians need to be able to critically evaluate the soundness and application of medical research studies in order to distinguish between beneficial preventive, therapeutic, and rehabilitative procedures from those that waste time and money, and may cause more harm than good.<sup>1</sup> A buzzword in medical education that describes the use of contemporary evidence for making patient care decisions is evidence-based medicine (EBM).<sup>2</sup>

EBM consists of being able to devise questions from clinical problems, finding and evaluating high quality, relevant evidence from the literature, and solving clinical problems with the most current information.<sup>3</sup> The life-long practice of EBM, including critical appraisal is a self-directed process that many medical practitioners have either limited or no

formal education in research and are not adequately prepared to critically analyze the quality of research they are reading.<sup>4</sup> More than 50% of medical school graduates report inadequate training in evaluating the methodological quality (i.e., critical appraisal) of biomedical literature.<sup>5</sup> Specific educational interventions targeting critical appraisal skills are prerequisite for medical students to become effective practitioners of EBM.<sup>6</sup>

The teaching of critical appraisal, a major component of EBM has been increasingly integrated into all levels of medical school curricula.<sup>7</sup> Several studies have described the teaching of critical appraisal and/or other components of EBM to first-year medical students. Riegelman<sup>8</sup> described sixteen-hour, required course at George Washington University School of Medicine, teaching first-year students how to review different types of studies (e.g., prospective studies and controlled clinical trials) and how to apply these data to clinical practice. Results from this study showed that the pre-clinical course in study design and statistics positively affected students' perceptions of their knowledge

**Table 1.** Critical Appraisal Project Timeline.

Histology Course (weeks)	Critical Appraisal Program Procedures
1-4	<ul style="list-style-type: none"><li>• MEDLINE instruction provided</li><li>• Biomedical publication selected</li></ul>
5-7	<ul style="list-style-type: none"><li>• Abstract from biomedical publication submitted for instructor approval (Table 2)</li></ul>
8-12	<ul style="list-style-type: none"><li>• Two 60-minute critical appraisal seminars given</li></ul>
13-14	<ul style="list-style-type: none"><li>• Set of critical appraisal questions answered (Fig. 1)</li><li>• One-page summary written (Fig. 2)</li></ul>
15	<ul style="list-style-type: none"><li>• Answers to critical appraisal questions and one-page summary submitted for instructor critique</li></ul>
16-19	<ul style="list-style-type: none"><li>• One-page summary revised (Fig. 3)</li><li>• Oral presentations prepared</li></ul>
20-21	<ul style="list-style-type: none"><li>• Oral presentations given (Fig. 5)</li></ul>

of study design and basic statistics. However, the author concluded that the effects of this preclinical course would be ineffective without opportunities for reinforcement in the clinical years.

Stacpoole and coworkers<sup>9</sup> reported teaching “hypothesis-oriented thinking” to first-year medical students. The authors indicate that clinical diagnosis is a “hypothesis-guided process” in which a patient states a chief complaint, and the physician formulates a set of diagnostic hypotheses that are tested during the history, physical examination and choice of laboratory tests. The entire freshman class served as either study subjects or investigators for hypothesis-driven experimental investigations in a clinical setting. Students’ survey responses of the research program indicated that most considered the hypothesis-driven program to be useful and relevant to their overall education.

Recently, Malathi and colleagues<sup>7</sup> described an eight-hour EBM course taught to first-year medical students. This program developed from a recommendation by third-year students to introduce EBM material before starting clinical rotations. Student satisfaction surveys and a faculty questionnaire indicated that both the students and the faculty were satisfied with the EBM course, and that the introduction of clinically relevant EBM material to first-year students was practical, feasible, and desirable.

A pilot program in which a “motivated” senior medical student designed and taught EBM and other clinically-focused topics (e.g., physical examination skills) to first-year medical students was recently reported by Josephson and Whelan.<sup>10</sup> The 16-hour, selective course was evaluated favorably by the first-year students, the fourth-year instructor and a faculty advisor. The authors concluded that the course filled an existing need in the first-year curriculum and that the program could be incorporated into diverse academic settings.

Published studies suggest that EBM, including critical appraisal is predominantly taught during the clinical years of medical school.<sup>7</sup> Dorsch and coworkers<sup>11</sup> reported using a multidisciplinary approach for teaching third-year medical students information retrieval and critical appraisal. The ten-week course consisted of medical faculty providing instruction in reading and evaluating research methodology, whereas the library faculty taught online literature searching. Based on formal evaluation and informal feedback, the course showed how the literature search was integral to the critical appraisal of medical literature and the clinical decision-making process.

The effects of two 90-minute interactive seminars on third-year medical students’ knowledge of research design, basic critical appraisal skills and attitudes toward the clinical use of medical literature was examined by Landry and colleagues.<sup>12</sup> Third-year students receiving the intervention were more likely to consider study design important in article selection and use of medical literature critical to patient care decisions compared to the 81 third-year control students. Moreover, the study group did show a significant increase in knowledge of critical appraisal. However, the two seminars did not increase use of medical literature in patient write-ups.

A case study by Fikree and Marsh<sup>13</sup> reported that the Department of Community Health Sciences of Aga Khan University Medical College taught critical reading of research to third-year students. The first two weeks of the program consisted of three one-hour classroom sessions and four one-hour small group sessions. Thereafter, small groups met monthly to review clinical epidemiological reports. A student questionnaire indicated that all students agreed that critical reading skills were essential, but only 30% strongly agreed that they had mastered the skills. Ninety-seven percent of the students disagreed that year three was too early to start critical reading.

How critical appraisal is taught to medical students during an obstetrics and gynecology rotation was described by Grimes and colleagues.<sup>14</sup> A series of seminars were given to foster critical reading of the literature and evidence-based ward rounds were used to provide practical application of critical appraisal skills. Although, the authors did not have a quantitative assessment of their approach, they indicated student feedback was enthusiastic.

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**Table 2.** Biomedical Publication Titles.

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<b>Group Number</b>	<b>Topics</b>
1	Glutathione peroxidase expression/ myocardial ischemia reperfusion injuries
2	Classification systems for curatively resected colorectal adenocarcinoma
3	Alpha-1 antitrypsin deficiency
4	Ultrastructure of airway epithelial cell membranes among patients with cystic fibrosis
5	Hepatic stellate cells in veno-occlusive disease of the liver
6	Aminoguanidine inhibition of autoimmune encephalomyelitis
7	Transplantability of bone marrow-derived mesenchymal cells
8	Intraoperative frozen section/ imprint cytological investigation / sentinel lymph nodes
9	Apoptosis /associated with atypical or malignant change in meningiomas
10	Sex-related differences in bronchial epithelial changes associated with tobacco smoking
11	Myofibroblasts. Paracrine cells important in health and disease
12	Apoptosis/expression in salivary gland tumors
13	Histology and electron microscopy of explanted bifurcated endovascular aortic grafts
14	Diagnosis of Pneumocystis carinii pneumonia/ monoclonal antibodies
15	Effects of parenterally administered triazolam on sleep in rats with preoptic area lesions
16	Asymmetry of cilia and of mice and men
17	Interleukin-1/ tumor necrosis factor/ wound strength
18	Apoptosis/ tumor cell differentiation/ uterine cervical carcinoma
19	Sunscreen application /betacarotene supplementation in prevention of skin carcinomas
20	Serum cardiac troponin I as a marker for detection of acute myocardial infarction
21	Histology correlation/ atypical squamous cells/ low-grade squamous intraepithelial lesions
22	Endometrial biopsy in dysfunctional uterine bleeding
23	Membrane-associated protein complex with selective binding / clathrin coat adaptor AP1
24	Immunohistochemical analysis /type-X-collagen expression in osteoarthritis of the hip joint
25	Penetration of the olfactory mucosal epithelium by Naegleria
26	Effects of folate supplementation in hyperhomocysteinemic pigs
27	Metallothionein expression in carcinoma of the gallbladder
28	Proteoglycan changes in the extracellular matrix of lung tissue
29	Origin of hyperplastic epithelial cells in idiopathic collapsing glomerulopathy
30	Direct evidence that mitochondrial iron accumulation occurs in Friedreich ataxia
31	Allergen-induced eosinophil cytolysis in human upper airways
32	Glycosylphosphatidylinositol –anchored membrane proteins in psoriatic skin
33	Apoptosis associated with bcl-2 expression in premalignant and malignant breast lesions
34	Distribution of lymphocytes and adhesion molecule in human cervix and vagina
35	The interleukin-1 type I receptor is expressed in human hypothalamus
36	Homocysteine and heart disease: pathophysiology of extracellular matrix
37	Predictors of renal transplant histology at three months
38	Identifying women with cervical neoplasia
39	The characteristics of umbilical cord blood and umbilical cord blood transplantation
40	Does histology influence outcome in childhood Hodgkin's disease?
41	A caspase-activated DNase that degrades DNA during apoptosis
42	Radial scars in benign breast-biopsy specimens and the risk of breast cancer
43	Lamivudine therapy for hepatitis B infection
44	The histopathology of cutaneous lesions of Kikuchi's disease
45	A comparison of three fingerstick, whole blood antibody tests
46	Regeneration of dorsal column fibers following adult spinal cord injury
47	Pulmonary pathology in Gaucher's disease
48	Histological phenotypes of enteric smooth muscle disease
49	Histochemistry to detect Helix pomatia lectin binding in breast cancer
50	Benign neoplasms of the skin
51	Induction of tumor necrosis factor alpha production by human hepatocytes
52	Immunohistochemical differentiation of metastases of renal carcinomas
53	Performance and muscle fiber adaptations to creatine supplementation
54	Skeletal myoblast transplantation for repair of myocardial necrosis
55	Papilloma viruses, warts, carcinoma and Langerhans cells
56	Changes in nasal epithelium in patients with severe chronic sinusitis

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The role of family medicine educators in teaching EBM to third-year students was described by Wadland and coworkers.<sup>5</sup> However, because clinical faculty had limited experience and training in critical appraisal and research methodology, they attended a 2-day training seminar given by McMaster University faculty before the EBM program was implemented. After clinical faculty training, nine 2- to 3-hour sessions were used to teach third-year students computerized literature searches, medical research paper structure, critical appraisal methods, and oral presentation skills. Survey results from this study showed higher levels of confidence in critical appraisal and research skills. Two cohorts followed into residency reported more appreciation of the instruction and skills obtained from the EBM program than did recent graduates. The authors indicate that the most important finding was that family medicine educators could successfully lead a standardized EBM program across multiple community campuses.

Ghali and colleagues<sup>6</sup> reported the effects of teaching a four-week EBM course to third-year medical students. Four 90-minute sessions were used to instruct students on clinical question development, MEDLINE searching, critical appraisal, and application of evidence. Third-year students receiving the EBM intervention reported increased self-assessed skills and attitudes, as well as a tendency to use MEDLINE and original research articles to solve clinical problems compared to a control group of third-year students. The authors concluded that the positive impact of their brief EBM intervention was due to active student involvement, clinical relevance and exposure to entire process of evidence-based problem solving.

Teaching critical appraisal to third-year students, using a journal club and letter writing approach during a three-week public health medicine attachment was described by Edwards and coworkers.<sup>15</sup> Small groups of students evaluated a recently published research paper, presented their appraisal to their peers in a journal club, and wrote a letter to the journal editor. Student feedback was "overwhelmingly positive" and 26 letters had been published or accepted for publication. The authors concluded that their approach was an innovative and enjoyable method for teaching critical appraisal and writing skills to medical students.

One study reported teaching EBM throughout the four-year undergraduate medical curriculum.<sup>4</sup> During the preclinical years, students were introduced to Medical informatics, literature appraisal skills and presentation skills in Library Sciences, Epidemiology and Microbiology, respectively. Students learned how to ask a clinical question based on an individual patient, search and appraise retrieved articles, and apply the information to the patient's medical problem during their clinical clerkships. The outcome measure developed to assess the program showed an improvement in students' search skill strategies, and ability to assess accurately the study's methodology and findings. However, students' ability to identify relevant studies in order to reach the appropriate conclusion about the question at hand was

equivocal. The authors concluded that more data were required before drawing a definitive conclusion about the effectiveness of their integrated approach.

Because undergraduate medical students are expected to learn massive volumes of basic and clinical science information in a relatively brief period, they become proficient at memorizing detailed information found in instructors' lecture notes, textbooks, and their own handwritten lecture notes. This type of learning lends itself to readily accepting the written and spoken word of authority, rather than the critical appraisal of information. To address this problem, we developed and implemented a resource-efficient method for introducing our first-year medical students to the critical appraisal of biomedical research publications. Our perception of students' interest toward studying histology was a second reason for conducting the study.

When we implemented our supplemental critical appraisal program into the first-year histology course, the University of Health Sciences College of Osteopathic Medicine (UHS-COM) was utilizing a conventional curriculum in which basic sciences were taught separate from the clinical sciences. Our students seemed to view basic sciences in general and histology in particular as a hurdle to get over in order to enter the clinical component of their medical education. Several studies corroborate this supposition by reporting that medical students' focus is on acquiring skills to practice clinical medicine<sup>16</sup> and a lack of interest toward basic sciences that are taught in conventional curricula.<sup>17-19</sup> Our students' indifference toward histology motivated us to implement a fresh and practical way of demonstrating histology's relevance to the field of medicine.

### Materials and Methods

At the beginning of the first-year histology course, medical students from the graduating class of 2003 (n = 224) at UHS-COM, were randomly divided into 56 groups of four students. A timetable outlining the entire critical appraisal program is listed in Table 1. During the first four weeks of the histology course, students were instructed on the basics of conducting a MEDLINE search and asked to review the biomedical literature for an article that contained histological and clinical elements. Groups were required to submit a copy of the abstract from their selected article for topic approval by the end of week eight. Students' publication topics are presented in Table 2.

Between weeks eight and 12 of the histology course, students were asked to attend two 60-minute seminars on how to critically appraise biomedical publications. The first seminar addressed the typical parts (i.e., abstract, introduction, materials and methods, results, discussion and conclusions) of a biomedical publication and how to critically analyze each component. The second seminar focused on questions to ask when reading diagnostic and treatment studies. A histology instructor gave both seminars during lunch. After the two critical appraisal seminars, groups were asked to meet at a mutually convenient time

and answer a set of critical appraisal-type questions (Figure 1). Groups were instructed to type a one-page summary of their approved article by week 12 of the course, using the guidelines provided in Figure 2. By week 15, groups submitted their one-page summary and the answers to the set of critical appraisal questions for instructor analysis.

During weeks 16-19 of the histology course, students revised their one-page summary based on instructor feedback and prepared a four-minute oral presentation for their classmates, faculty and administration. Group oral presentations were given during weeks 20 and 21 of the histology course. Each group member was required to present one of the following four components: introduction, methods, results, and discussion/analysis. After each group's oral presentation, first-year students, faculty and administration were encouraged to ask questions.

Group presentations were evaluated based on professional appearance and conduct, presentation organization, presentation clarity, analysis and critique, and the quality of the final abstract (Figure 3). These five attributes were worth four points each (i.e., 20 points total) towards the final histology course grade (460 total histology course points). Thus, the entire critical appraisal project was worth 4.3% of their final grade.

**Figure 1. Critical Appraisal-Type Questions.**

1. What do the terms used in the title mean?
2. What was the purpose of the study?
3. Why was the study needed?
4. What methods were used to address the research hypothesis?
5. What was the statistical hypothesis?
6. Why were the said statistical methods used for these data?
7. What did the results show?
8. Are the results consistent with the methods described?
9. Does the discussion highlight the important findings?
10. Was there needless speculation and discussion of unpublished data?
11. Did the conclusions answer the purpose of the study?
12. Do you agree with the conclusions made?
13. What would you have done differently?

**Table 3. Student Survey Results of Critical Appraisal Program.**

Survey Statements	1 to 5 Rating*; Number of students (n = 51); (%)					Mean Rating (S.D.)
	"1"	"2"	"3"	"4"	"5"	
Critical Appraisal program helped demonstrate relevance of histology to practice of medicine	2 (3.9%)	5 (9.8%)	6 (11.8%)	29 (56.9%)	9 (17.6%)	3.745 (0.997)
Other D.O. and/or M.D. medical students receive more critically appraisal training	3 (5.9%)	14 (27.4%)	12 (23.5%)	11 (21.6%)	11 (21.6%)	3.255 (1.246)
Critical Appraisal program positively affected my attitude toward histology	1 (2.0%)	8 (15.7%)	14 (27.4%)	20 (39.2%)	8 (15.7%)	3.510 (1.007)
Critical Appraisal program helped in other courses	1 (2.0%)	3 (5.9%)	9 (17.6%)	29 (56.9%)	9 (17.6%)	3.824 (0.865)
Time spent completing Critical Appraisal program was manageable	0 (0.0%)	0 (0.0%)	2 (3.9%)	38 (74.5%)	11 (21.6%)	4.176 (0.478)
Critical Appraisal program fostered collegiality among classmates	0 (0.0%)	2 (3.9%)	11 (21.6%)	25 (49.0%)	13 (25.5%)	3.961 (0.799)
Critical Appraisal program should be expanded throughout first and second years of medical school	2 (3.9%)	3 (5.9%)	12 (23.5%)	22 (43.2%)	12 (23.5%)	3.765 (1.012)
Critical Appraisal program was worth the effort	0 (0.0%)	3 (5.9%)	4 (7.8%)	32 (62.8%)	12 (23.5%)	4.039 (0.747)

Rating Scale: "1" indicates disagree strongly; "2" indicates disagree; "3" indicates no opinion; "4" indicates agree; and "5" indicates strongly agree

To determine whether the students considered our critical appraisal program useful and to address some related questions/issues, we constructed and administered a student survey to the class of 2003 during their senior year of medical school (Figure 4). Because our fourth-year students are completing their clinical clerkships throughout the United States, the survey was distributed via electronic mail. Survey responses were analyzed using Sigma Stat for Windows, version 2.03, SPSS, Inc.

## RESULTS

Fifty-one students from the class of 2003 (N = 224) completed and returned our Critical Appraisal Program student survey (Figure 4). Students were asked to rate each of the eight statements using the following scale: "1" indicates disagree strongly; "2" indicates disagree; "3" indicates no opinion; "4" indicates agree; and "5" indicates strongly agree. Using frequency analysis, Table 3 summarizes student ratings and the corresponding percent of total respondents for each of the eight statements. Additionally, the mean rating and standard deviation for each statement are also listed in Table 3.

The most populous consensus among nearly all respondents (i.e., 96.1% agreed and strongly agreed) was that the time needed to complete Critical Appraisal program was manageable. Nearly three-quarters of the respondents (74.5%) agreed and strongly agreed that the Critical Appraisal program demonstrated the relevance of histology to medicine, helped in other courses, and fostered collegiality among classmates. Two-thirds of respondents agreed and strongly agreed that the Critical Appraisal program should be expanded throughout the first and second years of medical school. More than one-half of respondents agreed and strongly agreed that the Critical appraisal program had a positive effect on their attitude toward histology. Survey respondents' rating for whether osteopathic and allopathic counterparts received more critical appraisal training was similarly distributed from disagree to agree strongly. Finally, more than fourth-fifths of respondents (86.3%) agreed and strongly agreed that the Critical appraisal program was worth the effort.

## DISCUSSION

Physicians indicate that medical journal reading is the most important activity for keeping updated, ranking above textbooks, colleagues, continued education courses, and pharmaceutical representatives.<sup>20</sup> Thus, critical analysis of published information is an essential component to the practice of medicine. The program described herein introduced critical reading of biomedical literature to first-year medical students, while illustrating the applicability of histology to the practice of medicine. Results from student survey data (Table 3) indicate that the course appraisal program was worthwhile and had a positive effect on their attitude toward histology. To motivate students to complete the critical appraisal program, students were graded on their group's one-page summary and platform presentation.

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### Figure 2. Instruction for One-page Summary.

The first part of the summary should contain the introduction. Definitions of the major terms used in the title, the clinical importance of the topic, and the purpose of the study are common items to put into the introduction. The second component of the summary is the material and methods section. This part usually consists of a few sentences describing the methodology used to investigate the clinical research question(s) (e.g., patient/subject number, clinical instruments used, etc.). Acquire a basic understanding of the clinical equipment/techniques used in the study before giving your oral presentation. The third part of the summary is the results. Quantitative and qualitative, clinically-measured outcomes are described in this section. Again, make sure that you have a basic understanding of results. For example, if data are presented as mean  $\pm$  standard deviation (SD), you should know why the SD is given. The fourth part of the summary is the conclusions of the study. It is imperative that you PARAPHRASE and not PLAGIARIZE the publication's abstract. Remember, you are required to submit the original abstract. The fifth and most important component of the summary is the analysis section. This is where your group describes the strengths, limitations, and applicability of the study. Do not forget to spell and grammar check your work. Plan to use transparencies for your oral presentation. Remember that you only have four minutes to present your study. You may want to use the first three minutes highlighting the introduction, methods, results and conclusions; and the last minute critically analyzing the study.

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Each group submitted a drafted version of their one-page summary to the histology instructors for review by week 15 of the course. The drafted summaries were evaluated on the basis of content, organization, distinctiveness from the publication's abstract, and grammar and spelling. Overall, the quality of the drafted one-page summaries ranged from very well written to poorly written. During weeks 16-19 of the course, each group had the option to revise their critiqued summary before its final submission (weeks 20-21). All groups chose to revise their drafted one-page summary before its final submission. The quality of the summary was worth only four points out of 460 total course points (<1% total course points). Although most students are "point-driven" in medical school, we believe students' pride and instructors' expectations may have played a role in their decision to revise their extensively reviewed one-page summary.

The quality of group oral presentations (Figure 4) was more impressive than their one-page summaries. Even though only about 3% (i.e., 16 points out of 460 total course points) of total histology course points were associated with each group's oral presentation, all groups appeared to have put a great amount of time and effort into this part of the critical appraisal program. All groups exhibited a high degree of professionalism, organization, clarity, and critical analysis during their verbal presentations. Students were advised to use either the document camera or the overhead projector for

the sake of simplicity, yet over 75% of groups created Microsoft PowerPoint® presentations that included scanned images and custom animations. Because no formal training was given on how to use Microsoft PowerPoint®, we believe that many students learned to use the program independently during the histology course. An unexpected and unsolicited comment made by many students was that the time and effort required to prepare their four-minute oral presentation gave them a greater understanding and respect for instructors' 50-minute lectures.

Although student, faculty and administration feedback for this program was enthusiastic, some areas of this program require further consideration for future use. Randomization of our first-year students (N = 224) into groups of four encouraged interactions among students that probably would not have otherwise occurred. Because our first-year students are permanently divided into the same four groups (i.e., A, B, C, and D) during the preclinical years for attending various basic science laboratories, some students expressed difficulty scheduling daytime group meetings when its members were not in the same laboratory group.

Students were encouraged to select a topic of interest, yet it was to contain histological and clinical components. Two issues related to topic selection that were not considered in the creation of this method were study/publication type and date of publication. The two critical appraisal seminars, and the critical appraisal questions and answers assignment were directed toward "experimental" type of biomedical publications. The type of study/publication selected by student groups was variable and included "review" articles, "retrospective" studies, "prospective" studies, "clinical trials," and biomedical "experimental" studies. Allowing students to select any type of publication exposed the first-year class to a variety of biomedical studies that was not addressed during the two critical appraisal seminars. A limitation to our approach was that some students were had difficulty in completing the project within its original format (e.g., data analysis).

Most students selected articles that were published within the last decade. However, several groups selected papers that were decades old. Because physicians should be able to critically evaluate the outcomes of contemporary medical research studies to provide the best possible patient care, we believe one of the greatest limitations of our critical appraisal program was not limiting the publication's date.

Although we provided our students with only two one-hour seminars on how to critically analyze biomedical publications, there is published data to support its usefulness. Landry and coworkers<sup>12</sup> found that after two 90-minute seminars, third-year medical students were more likely to consider study design important in article selection and the use of medical literature critical to patient care decisions. The format of our two one-hour seminars was kept informal and occurred during lunch. Seminar

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**Figure 3.** Example of a Group's Final Abstract.

**Transplantability and therapeutic effects of bone marrow-derived mesenchymal cells in children with osteogenesis imperfecta**

Osteogenesis Imperfecta (OI) is a genetic disorder involving abnormalities in mesenchymal cells which lead to a generalized osteopenia causing bone deformity, fractures, and fragility. A mutation in one of the two genes (**COL1A1**, **COL1A2**) coding for the primary structural protein of bone (collagen) is responsible for this progressive disorder which currently has no cure. Previous studies aimed at correcting this disorder came from murine models (rat studies). This is the first study in which human bone marrow was infused into human specimens. Three children suffering from OI due to genetic defects in collagen were used as subjects. The bone marrow was harvested from a sibling donor and intravenously infused into each patient. Chemoprophylaxis consisting of intravenous cyclosporine was given to each marrow recipient (2.5mg/kg every 12 hours) in order to reduce the chance of graft-versus-host disease. Each subject was evaluated prior to and following bone marrow transplantation. Results of the study were based on growth evaluation, bone histology studies, mesenchymal cell culture, chimerism studies, and dual energy x-ray absorptiometry. Bone biopsies taken from the iliac wing of each patient before and after the treatment demonstrated lamellar bone formation, greater osteoblast organization, and an increase in the number of osteoblasts per high-power field after transplantation { $4.6 \pm 1.8$  (s.e.m.) before and  $16.0 \pm 3.0$  after transplantation ( $P = 0.005$ , t-test)}. Other positive results were observed by the increase in total body bone mineral content in two of the three patients. One convincing factor which strongly supported the transplantation was the decreased number of fractures in all three patients. Therefore, this study demonstrates that mesenchymal progenitor cells in transplanted bone marrow of normal individuals give rise to osteoblasts. The presence of these new osteoblasts is seen in improved bone structure and function in individuals suffering from OI whose osteoblasts are genetically defective. Research indicates that the severity of OI depends on the ratio of normal to mutated pro-alpha polypeptide chains, therefore a relatively small percentage of mesenchymal cells (only 1.5 - 2.0% used in this study) may be enough to push the balance toward the normal side. It is possible that the increase in normal osteoblasts after the engraftment was short lived. It's also possible (though unlikely) that the therapeutic events seen after engraftment were caused by engraftment procedures (total-body irradiation & cytotoxic drugs). We feel that this study, being the first one to be conducted on humans, was very valuable and was conducted in a very scientific manner. It appears that protocols were followed in order to eliminate any errors due to bias and the results obtained seemed to be statistically and clinically significant. One aspect of the study that we felt was somewhat lacking was the number of subjects in the study. Another concern was that descriptive data about the control group wasn't listed. Overall we feel that this experiment justifies further tests to be performed in order to determine if infusing donor bone marrow into OI patients results in a cure for the disease.

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information was presented in PowerPoint® format and placed on our intranet for students unable to attend.



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#### Figure 4. Student Survey of Critical Appraisal Program

- A. The Critical Appraisal program helped demonstrate the relevance of histology to the practice of medicine.
  - B. Other D.O. and/or M.D. medical students receive more training on how to critically read and evaluate biomedical literature than we did at UHS.
  - C. The Critical Appraisal program had a positive effect on my attitude toward the histology course.
  - D. The Critical Appraisal program was helpful in other courses.
  - E. The time spent completing the Critical Appraisal program was manageable.
  - F. The Critical Appraisal program fostered collegiality among classmates.
  - G. The content of the Critical Appraisal program should be expanded and delivered throughout the first and second years of medical school.
  - H. The Critical Appraisal program was worth the effort.
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#### CONCLUSION

Clinicians must be trained to not accept published medical research studies at face value, but to form their own conclusions after careful and critical review. The program described herein is a resource-efficient way to introduce critical reading of biomedical literature to first-year medical students, while illustrating the applicability of microscopic anatomy to the practice of medicine. Our critical appraisal program also gave students a “taste” of scientific writing and an opportunity to learn platform presentation skills.

#### ACKNOWLEDGEMENTS

The authors would like to thank Ms. Nancy L. Stroud, UHS-COM Interlibrary Loan Specialist, for retrieving and compiling manuscript references.

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**Figure 5.** Example of Two Groups' Oral Presentation.

