Testing osteopathic medical school graduates for licensure: Is COMLEX–USA the most appropriate examination?

JOHN GRANETO, DO, MEd

Osteopathic and allopathic physicians receive authority to practice medicine through the licensing boards of the states in which they practice. Each state has the responsibility to operate a licensing board for physicians and other medical professionals. These boards choose which examinations are acceptable to establish that a physician is licensable to practice medicine. The National Board of Osteopathic Medical Examiners (NBOME) administers the Comprehensive Osteopathic Medical Licensing Examination (COMLEX–USA). To determine the views of the educational leaders of the osteopathic profession regarding licensure testing, a survey was mailed to leaders in the profession. Of the 799 surveys mailed, 341 (43%) were returned. Respondents were asked 19 questions, using a Likert scale to record responses (strongly disagree, 1; strongly agree, 5).

Eighty-eight percent of respondents believed that osteopathic medicine is a distinct profession. Seventy percent of respondents felt that COMLEX–USA is the standard for testing osteopathic trainees, while 70% believed trainees should continue to be tested by a unique process. According to 72% of the respondents, the NBOME, through its testing procedures, continues to be the organization best suited to test the knowledge of osteopathic students and graduates. These results indicate that among the practicing leadership of the osteopathic profession, overwhelming support exists for the profession to retain the ability and the right to examine its own trainees from within.

(Key words: medical education, National Board of Osteopathic Medical Examiners, Comprehensive Osteopathic Medical Licensing Examination)

Osteopathic and allopathic physicians receive authority to practice medicine through the licensing boards of the states in which they practice. To obtain a license, a graduate must pass the certifying examination approved by his or her respective state’s medical board. Forty-nine states currently accept the Comprehensive Osteopathic Medical Licensing Examination (COMLEX–USA) —developed and administered by the National Board of Osteopathic Medical Examiners (NBOME) —as the standard for graduates of osteopathic medical schools. In all states, the United States Medical Licensing Examination (USMLE) is the accepted standard for graduates of allopathic medical schools; a small number of osteopathic graduates opt to take this examination as well. The Federation of State Medical Boards (FSMB) and the National Board of Medical Examiners (NBME) are the parent organizations of the USMLE.

Some members of the various state medical licensing boards have questioned the need for the NBOME’s unique product for licensure for graduates of osteopathic medical schools (G. Osborn, DO, oral communication, March 1999). They suggest that osteopathic and allopathic graduates be examined by the same test, the USMLE. In 1999, concerns were also raised regarding the statistical validity of both the USMLE and the COMLEX–USA. To attempt to answer these concerns, a special committee was appointed to research the ongoing validity studies for both examinations.

Distinctly osteopathic organizations—NBOME, the American Osteopathic Association (J. Crosby, oral communication, March 1999), and the American Association of Colleges of Osteopathic Medicine (D. Wood, DO, oral communication, March 1999)—support the position that graduates of osteopathic medical schools should continue to be tested for licensure by an osteopathically focused examination rather than an allopathically focused one. Although the scope of practice and the skills learned by allopathic and osteopathic students are similar in many respects, allopathic and osteopathic schools actually embrace two different and distinct philosophies and curricula and thus produce two distinct professions. No evidence convincingly supports a contention that the graduates of two separate and distinct disciplines should be tested for licensure by the same examination. “By adopting the allopathic examination, the osteopathic profession would be under great pressure to change its approach to undergraduate and graduate medical education.”

Osteopathic history

The history of the osteopathic profession testifies to the existence of a distinct and parallel medical education system as well as a distinct philosophy of medical practice. Thus, the leaders of the osteopathic profession promote the continued recognition of the osteopathic profession as a unique and sovereign profession. They point to distinctive osteopathic training curricula, separate accreditation of its schools, and postdoctoral training programs as proof of its parallel status. Therefore, they conclude that the separate licen-
The historical roots of osteopathic medicine base the profession’s educational focus on three distinct principles. These principles illustrate the major distinction between the osteopathic profession and the allopathic profession: (1) osteopathic physicians have been trained to believe that the body is integrally related as whole being; (2) the body has the innate ability to heal itself; and (3) through proper body structure, proper body function can flourish.

One noticeably measurable difference between the osteopathic and the allopathic curricula derives from the “extra” hours spent on the manual diagnostics and treatments that support these three principles. When trying to elucidate the difference between the professions, “manual medicine” is often perceived as the sole reason for the osteopathic profession’s separate status. However, the aforementioned principles permeate the entire curriculum and provide the overriding rationale for maintaining two realms of medical thought, practice, and licensure. The outcome of this osteopathic curriculum demonstrates that the profession promotes a successful pattern of graduates who eventually practice in primary care settings in a greater proportion than students who graduate from allopathic schools.

Isolation of the osteopathic profession caused by its early designation as a “cult” by the allopathic profession drove the profession to establish its own professional organizations and infrastructure distinct from the mainstream medical profession. Thus, the historical perspective shows that the osteopathic profession, which developed its own schools, accrediting bodies, and hospitals, also had to develop its own licensure pathways to reflect the unique curriculum and philosophical differences. This pathway to licensure was born mostly out of a need to license the graduates of its programs and grew from that time when the traditional medical profession excluded osteopathic graduates from its own licensure examination process and denied them practice in its hospitals. In 1919, in Shaw vs. Ohio, the Ohio state court recognized the distinctiveness of the practice of osteopathic medicine as a separate profession from allopathic medicine and not as a limited branch of traditional medicine. By the 1930s, 46 states had approved laws allowing for the licensure of osteopathic physicians, and nearly half of those states had a separate board to license the osteopathic graduates; these states obviously viewed osteopathic medicine as a separate and distinct profession.

Although early on, the individual states offered their own independent examinations heavily weighted with basic sciences, one by one, the states gradually accepted the NBOME’s examination as the accepted route to licensure for osteopathic physicians. Similarly, the profession itself continued to strive to gain acceptance from the traditional “majority” medical profession. Finally, the acceptance of osteopathic physicians as fully licensed physicians in the United States has led to several changes in practice settings traditionally open only to allopathic physicians.

Opportunities to train and practice side by side with allopathic physicians allowed for osteopathic physicians to achieve more recognition and acceptance. Some suggest that this struggle for acceptance resulted in decreased attention to the differences between the two professions; however, the philosophical foundation of the osteopathic profession continues to distinguish it from the allopathic profession. Educationally, legally, historically, and practically, the osteopathic profession remains distinct and separate from allopathic medicine. This situation not only warrants a separate examination process, but also demands it (R. Foster, unpublished data, April 1998). It remains the individual state licensing board’s right to decide which examinations are acceptable to meet criteria for licensure.

State licensure

Each state has the responsibility, as established by the legislature, to operate a licensing board for physicians and other medical professionals. These boards control the regulations required to license physicians, including both the review of questions concerning conduct and of credentials for practice. The states have the responsibility to ensure that the licensed practitioner has the minimal medical knowledge sufficient to practice medicine safely. By certifying that a physician has the basic skills and knowledge to begin practicing, the state board ensures the safety of the people.

All state medical boards assess a physician’s readiness for practice through a minimum evaluation of four requirements: (1) the applicant must complete a recognized program of medical school training, (2) the individual must pass a licensing examination approved by that individual’s state medical board, (3) the applicant must complete some standard amount of postgraduate training, and (4) the applicant must possess good moral character. These requirements apply to osteopathic and allopathic physicians, regardless of the licensing examination taken. The state has the right to administer its own licensing examination or to accept one administered by a national organization such as the NBOME.

National Board of Osteopathic Medical Examiners

The NBOME, a not-for-profit corporation, serves the public and the state licensing agencies by administering examinations testing the medical knowledge of those seeking to practice as osteopathic physicians. Established in 1934, it administered the first examinations in February 1935 and awarded the first certificates in July 1936. The NBOME examinations have been the primary pathway by which osteopathic physicians have applied for licensure to practice osteopathic medicine. Ninety-two percent of graduates of osteopathic schools in 1997 and 1998 were first-time test takers for the Level 3 COMLEX—USA in 1998 and 1999, respectively.

The NBOME assists the state licensing boards in their efforts to accurately measure the knowledge required by today’s physicians. In the late 1990s, the NBOME initiated the three-part COMLEX—USA to replace the three-level NBOME examination series. The NBOME asserts that a
<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly agree, No. (%)</th>
<th>Agree, No. (%)</th>
<th>Neutral, No. (%)</th>
<th>Don’t know, No. (%)</th>
<th>Disagree, No. (%)</th>
<th>Strongly disagree, No. (%)</th>
<th>Total responding, No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Osteopathic medicine is a distinct profession.</td>
<td>173 (50.7)</td>
<td>127 (37.2)</td>
<td>27 (7.9)</td>
<td>0 (0)</td>
<td>13 (4.1)</td>
<td>1 (0.3)</td>
<td>341 (100.0)</td>
</tr>
<tr>
<td>COMLEX–USA† is the standard for testing osteopathic physicians.</td>
<td>133 (39.0)</td>
<td>105 (30.8)</td>
<td>40 (11.7)</td>
<td>44 (12.9)</td>
<td>9 (2.6)</td>
<td>7 (2.0)</td>
<td>338 (99.1)</td>
</tr>
<tr>
<td>Minimal knowledge to practice is best tested in a three-part exam process.</td>
<td>53 (15.5)</td>
<td>121 (35.5)</td>
<td>63 (18.5)</td>
<td>47 (13.8)</td>
<td>32 (9.4)</td>
<td>19 (5.6)</td>
<td>335 (98.2)</td>
</tr>
<tr>
<td>There should continue to be a distinct pathway to licensure.</td>
<td>151 (44.3)</td>
<td>89 (26.1)</td>
<td>43 (12.6)</td>
<td>1 (0.3)</td>
<td>14 (4.1)</td>
<td>19 (5.6)</td>
<td>317 (93.0)</td>
</tr>
<tr>
<td>The NBOME‡ is best suited to test osteopathic physicians for licensure.</td>
<td>149 (43.7)</td>
<td>100 (29.3)</td>
<td>46 (13.5)</td>
<td>17 (5.0)</td>
<td>11 (3.2)</td>
<td>12 (3.5)</td>
<td>335 (98.2)</td>
</tr>
<tr>
<td>A distinct osteopathic exam pathway benefits patients.</td>
<td>104 (30.5)</td>
<td>86 (25.2)</td>
<td>95 (27.8)</td>
<td>6 (1.8)</td>
<td>28 (8.2)</td>
<td>21 (6.2)</td>
<td>340 (99.7)</td>
</tr>
<tr>
<td>Ongoing research is necessary for NBOME products.</td>
<td>193 (56.6)</td>
<td>112 (32.8)</td>
<td>23 (6.7)</td>
<td>9 (2.6)</td>
<td>2 (0.6)</td>
<td>2 (0.6)</td>
<td>341 (100.0)</td>
</tr>
<tr>
<td>Alternative delivery methods should be developed.</td>
<td>104 (30.5)</td>
<td>121 (35.5)</td>
<td>68 (19.9)</td>
<td>28 (8.2)</td>
<td>9 (2.6)</td>
<td>3 (0.9)</td>
<td>333 (97.6)</td>
</tr>
<tr>
<td>Standardized patients should be part of COMLEX–USA.</td>
<td>86 (25.2)</td>
<td>135 (39.6)</td>
<td>69 (20.2)</td>
<td>18 (5.3)</td>
<td>21 (6.2)</td>
<td>7 (2.0)</td>
<td>336 (98.5)</td>
</tr>
<tr>
<td>COMLEX–USA content should affect COM§ curriculum planning.</td>
<td>79 (23.2)</td>
<td>127 (37.2)</td>
<td>54 (15.8)</td>
<td>14 (4.1)</td>
<td>39 (11.4)</td>
<td>23 (6.7)</td>
<td>336 (98.5)</td>
</tr>
</tbody>
</table>

* Likert five-point scale: 5 = strongly agree; 4 = agree; 3 = neutral; 2 = disagree; 1 = strongly disagree; 0 = don’t know.
Total of percents of responses may not equal total percent in last column because of rounding.
† COMLEX–USA = Comprehensive Osteopathic Medical Licensing Examination.
‡ NBOME = National Board of Osteopathic Medical Examiners.
§ COM = college of osteopathic medicine.
¶ GME = graduate medical education.
* USMLE = United States Medical Licensing Examination.
<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly agree, No. (%)</th>
<th>Agree, No. (%)</th>
<th>Neutral, No. (%)</th>
<th>Don't know, No. (%)</th>
<th>Disagree, No. (%)</th>
<th>Strongly disagree, No. (%)</th>
<th>Total responding, No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ COM curriculum planning should affect COMLEX–USA content.</td>
<td>102 (29.9)</td>
<td>160 (46.9)</td>
<td>42 (12.3)</td>
<td>14 (4.1)</td>
<td>13 (4.2)</td>
<td>7 (2.1)</td>
<td>338 (99.1)</td>
</tr>
<tr>
<td>□ COM curriculum is currently reflected in COMLEX–USA.</td>
<td>19 (5.6)</td>
<td>85 (24.9)</td>
<td>98 (28.7)</td>
<td>115 (33.7)</td>
<td>17 (5.0)</td>
<td>5 (1.5)</td>
<td>339 (99.4)</td>
</tr>
<tr>
<td>□ COMs should emphasize osteopathic distinctiveness.</td>
<td>209 (61.3)</td>
<td>111 (32.6)</td>
<td>13 (3.8)</td>
<td>3 (0.9)</td>
<td>1 (0.3)</td>
<td>2 (0.6)</td>
<td>339 (99.4)</td>
</tr>
<tr>
<td>□ NBOME should emphasize osteopathic distinctiveness.</td>
<td>94 (27.6)</td>
<td>120 (35.2)</td>
<td>58 (17.0)</td>
<td>5 (1.5)</td>
<td>38 (11.1)</td>
<td>23 (6.7)</td>
<td>338 (99.1)</td>
</tr>
<tr>
<td>□ GME programs should emphasize osteopathic distinctiveness.</td>
<td>151 (44.3)</td>
<td>134 (39.3)</td>
<td>34 (10.0)</td>
<td>3 (0.9)</td>
<td>10 (2.9)</td>
<td>5 (1.5)</td>
<td>337 (98.8)</td>
</tr>
<tr>
<td>□ Distinct departments of medical education should be at each COM.</td>
<td>120 (35.2)</td>
<td>108 (31.7)</td>
<td>70 (20.5)</td>
<td>19 (5.6)</td>
<td>9 (2.6)</td>
<td>9 (2.6)</td>
<td>335 (98.2)</td>
</tr>
<tr>
<td>□ There are significant differences between COMLEX–USA and USMLE.†</td>
<td>58 (17.0)</td>
<td>89 (26.1)</td>
<td>53 (15.5)</td>
<td>118 (34.6)</td>
<td>17 (5.0)</td>
<td>3 (0.9)</td>
<td>338 (99.1)</td>
</tr>
<tr>
<td>□ COMLEX–USA and USMLE content should be explicitly compared.</td>
<td>79 (23.1)</td>
<td>112 (32.8)</td>
<td>62 (18.2)</td>
<td>42 (12.3)</td>
<td>14 (4.1)</td>
<td>26 (7.6)</td>
<td>335 (98.2)</td>
</tr>
<tr>
<td>□ Allopathic medical students should be allowed to take COMLEX–USA.</td>
<td>49 (14.4)</td>
<td>77 (22.6)</td>
<td>71 (20.8)</td>
<td>22 (6.4)</td>
<td>48 (14.1)</td>
<td>70 (20.5)</td>
<td>337 (98.8)</td>
</tr>
</tbody>
</table>

* Likert five-point scale: 5 = strongly agree; 4 = agree; 3 = neutral; 2 = disagree; 1 = strongly disagree; 0 = don't know.
Total of percents of responses may not equal total percent in last column because of rounding.
† COMLEX–USA = Comprehensive Osteopathic Medical Licensing Examination.
‡ NBOME = National Board of Osteopathic Medical Examiners.
§ COM = college of osteopathic medicine.
∥ GME = graduate medical education.
¶ USMLE = United States Medical Licensing Examination.
passing score on its examinations verifies a student’s adequacy of medical knowledge for practicing osteopathic medicine. The COMLEX–USA series employs a primary care approach to patient care, with emphasis on the generalist curriculum taught in the osteopathic medical schools. Additional focus is placed on disease prevention and health promotion as distinguishing features of osteopathic medicine fully integrated throughout the examination.10

Test development procedures include submission of questions for the examinations by various practicing osteopathic physicians from the community setting and from academic centers. Two committees of osteopathic physicians with years of experience in the test development process then review each item. Committees are principally composed of faculty members from the various osteopathic medical schools. These review committees discuss content, level of difficulty, and whether items reflect osteopathic philosophic differences, including emphasis on primary care. Placement of items into the examinations is guided by several outlines reflecting the osteopathic curriculum’s generalist approach to high-frequency and high-impact clinical encounters. A separate committee of osteopathic physicians then reviews each prepared examination before it is administered. After each examination administration, doctorate-level statisticians review each of the question items to evaluate their individual validity. This review process assures the overall quality of the examinations.

Forty-nine state licensing boards have accepted the examinations developed by the NBOME, and validity studies now under way will undoubtedly reveal the COMLEX–USA as an appropriate examination tool to assess osteopathic medical graduates. The most recent validity study conducted by the University of Chicago reported, “When the psychometric properties of COMLEX–USA examinations are compared point by point with the properties of the many other licensure and certification examinations we have analyzed, COMLEX–USA proves to be equal to any and better than most” of the other examinations.11 This type of conclusion by an outside reviewer continues to add evidence that the COMLEX–USA is a quality product available to FSMB members.

**Federation of State Medical Boards**

Most state medical boards belong to an umbrella organization, the FSMB. The FSMB, formed in 1912, suggested that the requirements for graduating from a medical school and the requirements to practice medicine safely were distinguishable from each other. The FSMB, as a parent of the NBME, supports the development and administration of the USMLE,12 predominantly used to test graduates of allopathic medical schools. A passing score on either the USMLE or the COMLEX–USA indicates to the FSMB that the medical student has attained a certain minimal level of knowledge to safely practice medicine. The COMLEX–USA—based on the osteopathic curriculum and philosophy—and the USMLE—based on the allopathic curriculum and philosophy—are both designed to assess a physician’s ability to apply knowledge, concepts, and principles important to both health and disease, and that constitutes the basis of safe and effective patient care.

The USMLE, like the COMLEX–USA, has three steps in the examination process. Each step is complementary to the others; no step can stand alone in the assessment of readiness for medical licensure. Examination committees, composed of medical educators and clinicians with recognized prominence in their respective fields, prepare the materials for each step of the examination. Committee members are selected to provide broad representation from the academic, practice, and licensing communities across the United States and Canada.13 While graduates from osteopathic medical schools are also eligible to take the USMLE as a process for licensure, only a minority of osteopathic students opt to take the USMLE in addition to the COMLEX–USA.14

It has been suggested that the USMLE is sufficiently similar to the COMLEX–USA to be substituted for the COMLEX–USA, but there has not been any specific comparison of respective contents. “Whenever a test is considered for a use other than its originally intended purpose, it is particularly important to know characteristics even better, to ensure that its alternative use is appropriate and that its interpretation in the new setting is performed with the necessary cautions and restrictions.”15 The question before the osteopathic community is this: What do educational leaders think about the importance of the osteopathic profession to continue to let it offer its own unique licensure examination?

**Methods**

To gauge the osteopathic profession’s view of the NBME and the COMLEX–USA, the author used a survey instrument containing items related to the current testing products, the testing process, and the philosophy of the profession. In May 1999, the survey was mailed to 799 leaders in the osteopathic profession who serve as deans or presidents of osteopathic medical schools, their associate deans for academic affairs, internship directors of medical education, residency training program directors, individual members of the American Association of Osteopathic Examiners, and presidents of the state osteopathic associations. Names and addresses were obtained from the offices of the Executive Director of the AOA. Of the 799 surveys sent, 341 (43%) completed surveys were returned. No attempts were made to recontact the nonresponders. Although respondents had the opportunity to place their names on the survey, individual responses were kept anonymous and confidential. The survey tool used 19 questions on a Likert scale ranging from strongly agree (5) to strongly disagree (1). In addition, three open-ended questions allowed respondents to answer with narrative about the COMLEX–USA examination process.

**Results**

Over 95% of the respondents indicated that they were board certified; the most
frequently reported board certifications included family practice, emergency medicine, internal medicine, general surgery, obstetrics/gynecology, and pediatrics (Table). Although the response rate was only 43%, specialties listed by the respondents reflected the general overall distribution of AOA membership, that is, heavily populated by family practice.

The first item related to the distinctiveness of the profession. Survey participants overwhelmingly regarded the osteopathic profession as a distinct profession, with 88% agreeing or strongly agreeing. Other items related to the profession’s distinctiveness showed that respondents generally agreed that the distinctiveness of the osteopathic profession should be emphasized by the osteopathic colleges (93%) as well as through graduate medical education programs (83%) and by the NBOME (62%).

Regarding the COMLEX–USA as the standard for testing, 70% of respondents support COMLEX–USA as the standard for testing osteopathic graduates. Seventy percent of respondents felt that there should continue to be a distinct pathway for licensure for osteopathic graduates. They also confirmed their support (73%) for the NBOME as the organization best suited to test osteopathic physicians for licensure. Recognizing concerns over the increasing need for research on the examinations, 88% of the respondents concurred that ongoing research for all NBOME testing products is necessary.

With regard to COMLEX–USA content, 60% of respondents felt that examination content should affect curricula of the colleges of osteopathic medicine. Seventy-six percent felt that the curriculum should affect the COMLEX–USA.

Responses pertaining to the examination process indicate that half of the respondents felt that the minimal knowledge needed to practice osteopathic medicine is best tested in the three-part examination process; 65% believe that standardized patients should be a part of the COMLEX–USA. Fifty-five percent of respondents thought that the distinct osteopathic testing process benefits patients. Sixty-five percent supported administering the examination via alternative delivery methods (that is, computer based).

When asked whether respondents knew that osteopathic college curricula are represented in the COMLEX–USA, 34% did not know or had no opinion, while 29% were neutral. Thirty-four percent of respondents either did not know whether significant differences existed between the USMLE and the COMLEX–USA or had no opinion on the subject, while 15% were neutral. Fifty-five percent felt that the USMLE should be compared with the COMLEX–USA.

The most significant disagreement between respondents surrounded the idea that allopathic students should be allowed to be tested with the COMLEX–USA: 34% did not think they should be allowed; 37% thought they should be allowed; and 27% did not know, had no opinion, or were neutral.

Comments

Survey respondents felt that osteopathic medical students receive a unique professional education and should, therefore, be tested by a unique process. The osteopathic medical education infrastructure, at both the undergraduate and graduate levels, serves to emphasize the unique features of the profession. This educational structure, specifically through the product of its educational process, osteopathic students, and graduates, continuously undergoes rigorous testing by the COMLEX–USA, as administered by the NBOME. The NBOME, through its constant inspection of the distinct nature of osteopathic education, also serves to emphasize that distinctiveness.

Through its testing procedures, the NBOME continues to be the organization best suited to test osteopathic students’ performance on the COMLEX–USA, as well as the continued need for validity evidence is apparent. These hurdles must be overcome in order for the profession to continue toward more solid consensus regarding licensure.

The various state licensing boards, established by the state legislatures, adhere to a mission that includes protection of the public. Therefore, allowing the profession to develop and examine its own trainees best protects the patients served by the osteopathic physicians; the justification sought by the Federation of State Medical Boards for a single pathway does not appear to be supported by the osteopathic profession at this time.

References

MDs and DOs. New York, NY: Josiah Macy, Jr. Foundation; 1996.


Future issues of JAOA

- “Predicting factors of successful recovery from lumbar spine surgery in workers’ compensation patients”
- “Correlation of scores for the COMLEX–USA with osteopathic medical school grades”
- “Black widow bites in children”
- “Prediction of student performances on COMLEX–USA Level 1 examination based on admission data and course performance”
- “Clinical experience using intracorporeal lithotripsy with the Swiss lithoclast”
- “Weaning from mechanical ventilation: an update”
- “Occupational and environmental medicine in a family medicine residency”
- “The cranial rhythmic impulse related to the Traube-Hering-Mayer oscillation: comparing laser-Doppler flowmetry and palpation”
- “A decline in structural examination compliance in the hospital medical record with advancing level of training”
- “Adjunctive osteopathic manipulative treatment in women with depression: a pilot study”
- “The muscle hypothesis: a model of chronic heart failure appropriate for osteopathic medicine”
- “The primary care physician’s role in caring for internationally adopted children”
- “Student perceptions of osteopathic manipulative treatment after completion of a manipulative medicine rotation”
- “Oral polymeric N-acetyl-glucosamine and arthritis”
- “The effect of cooling prior to a marathon race on muscular health”
- “Manual medicine diversity: research pitfalls and the emerging medical paradigm”
- “Evaluation of spine injury in trauma patients”