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AUTHOR Erdmann, James B.; And Others
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ABSTRACT

The evolution of the Medical College Admission Test (MCAT), its present constitution and operation, and plans for its future are discussed. Also included is a current selected bibliography on the test. (AG)

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THE MEDICAL COLLEGE ADMISSION TEST:

PAST, PRESENT, FUTURE

James B. Erdmann, Ph.D., Dale E. Mattson, Ph.D., Jack G. Hutton, Jr., Ph.D.,
and
Wimburn L. Wallace, Ph.D.

The primary purpose of this article is to take three somewhat distinct looks at the Medical College Admission Test (MCAT): (a) Its evolution, (b) its present constitution and operation, and (c) plans for the future. A secondary purpose is to provide in the literature an up-to-date selected bibliography on the test. The intended audience for the article is twofold: (a) a large group of medical educators who are interested in the continuing improvement of medical care and its delivery through improvement of the process and product of medical education, but who are not specialists in either psychometrics or student admissions; and (b) an increasingly sophisticated group of pre-medical advisors.

The most complete source of information on the MCAT is the Handbook for Admissions Committees, Second Edition (1). This is a rather comprehensive "test manual," but, for the intended audiences of the present article, it may be lengthy and somewhat technical. Additionally, Sanazaro and Hutchins (2) briefly presented the origin and nature of the test in an article written primarily as a rejoinder to another article (3). Two complimentary reviews (4,5) discuss the technical

Dr. Erdmann is Director, Division of Educational Measurement and Research, Association of American Medical Colleges, Washington, D.C.

Dr. Mattson is Director, Office of Admissions and Records, University of Illinois Medical Center, Chicago. Former Director, Division of Educational Measurement and Research, Association of American Medical Colleges.

Dr. Hutton is Assistant Director, Division of Educational Measurement and Research, Association of American Medical Colleges, Washington, D.C.

Dr. Wallace is Director, Professional Examinations Division, The Psychological Corporation, New York City.

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qualifications of the MCAT as a psychometric instrument, although these are probably unfamiliar to most medical educators since they appear in the literature of educational-psychological measurement and not the literature of medical education. And, as will be well known to many in the intended audiences, numerous authors have addressed themselves to the use of the MCAT in medical college admissions work (see Selected MCAT Bibliography). As the reader continues on in this article, it will be useful to keep in mind a distinction between (a) the MCAT as an educational-psychological measuring instrument--i.e., the psychometric properties of the test--and (b) the MCAT as a tool for admissions committees--i.e., the uses made of the test scores. But first let us consider the historical background of the MCAT.*

PAST

Objective, standardized tests were first used as part of the screening or admissions process in some scattered medical colleges on a local basis in the 1920's. Beginning in 1930, the Association of American Medical Colleges (AAMC) sponsored a nationwide testing program for the selection of medical students. It has continued its sponsorship of such a program ever since. During the decade or two following 1930, more and more of the colleges of medicine adopted this program until eventually most all of them either required or strongly recommended it for their applicants.

* Most of what follows under PAST and much of the PRESENT portion of this article have been taken from a paper presented by Dr. Wallace at a conference on "Preparation for Medical Education in the Traditionally Negro College" co-sponsored by the Josiah Macy, Jr. Foundation, the Southern Regional Education Board, and the Association of American Medical Colleges, and held in Atlanta, Georgia, in February 1968.

From 1930 until 1946, the instrument used in this program was the Scholastic Aptitude Test for Medical Schools developed by F. A. Moss. Although periodically revised and modified, this test followed a consistent approach in its successive forms. The test comprised eight parts, although it yielded only one composite score which was reported to the medical colleges. The test was replete with true-false questions but also had some items of the multiple-choice variety. Included were items intended to measure scientific vocabulary, pre-medical information, memory for verbal content of a medical nature, memory for names of parts on an anatomical diagram, reading comprehension, and logical reasoning. Several of these tasks were obviously designed to parallel the type of learning required in medical school, especially during the first two years--the traditional "preclinical" years.

During the years the Moss test was in use, a number of studies indicated that it was doing a reasonably good job of predicting success in medical schools, particularly in the preclinical or basic science courses. Its accuracy of prediction varied a good deal from one medical school to another due to differences in the heterogeneity of the student populations, differences in grading standards, and other variable factors. This situation continues to be the case today not only in medical education but in other fields as well.

In the mid-1940's the AAMC turned the program over to the Graduate Record Office where the Professional School Aptitude Test was developed and put into use beginning in 1946. This test differed in a number of ways from its predecessor. It was longer and yielded four separate scores instead of a single score. The four parts were: Verbal, Quantitative, Science, and Understanding Modern Society. This

composition seems to reflect a rather different testing philosophy than that exemplified by the Moss test. The concentration on science was diluted, and the content was not chosen primarily to be a sample of the type of learning encountered in medical schools. The role of memory, especially for rote materials, was de-emphasized. Furthermore, the test provided an appraisal of general cultural background and knowledge of current affairs, although such information was recognized as probably showing little relationship with medical school grades. The emphasis appears to have been more on an evaluation of general academic aptitude, knowledge, and intellectual skills that may have been judged desirable for the prospective physician.

When the Graduate Record Office became part of the newly created Educational Testing Service in 1948, the program was included in the amalgamation. The name of the test was changed from the Professional School Aptitude Test to the Medical College Admission Test, although the test itself was not changed. Successive parallel forms of the test were developed in the next few years, but it remained essentially the same instrument which was used from 1946 until 1962.

In 1960, the AAMC transferred the program from Educational Testing Service to The Psychological Corporation. The AAMC requested The Psychological Corporation to keep the same general framework of the MCAT but to build entirely new tests with certain modifications. Among these changes were to be a reduction in the amount of reading involved, a reduction in speededness or time-pressure in the examination, and a broadening of the Modern Society section to a sampling of nonscience information in general. Accordingly, this "general" section of the test was re-labeled General Information. The new

revision of the MCAT was put into use in 1962 after two years of development, and alternate forms of the same type of examination have been used ever since.

PRESENT

Verbal and quantitative tests are basic components of almost every examination of general scholastic ability designed to predict academic performance. For well over half a century it has been recognized and repeatedly demonstrated that performance on samples of exercises in these fundamentals predict academic achievement not perfectly, but well. The relative importance of abilities in these two domains, verbal and quantitative, varies from one field to another. If the relative emphasis given to the parts of the MCAT by medical school admissions committees can be taken as a guide, the ability to reason and solve problems in quantitative terms seems to be somewhat more important for a medical student than facility with verbal concepts and skill in verbal reasoning.

The general framework of the MCAT is as follows:

<u>Subtest</u>	<u>Number of Items</u>	<u>Testing Time</u>
Verbal Ability	75	20 min.
Quantitative Ability	50	45 min.
General Information	75	25 min.
Science	86	60 min.

The Verbal Ability subtest consists of 75 questions or items, 30 based on synonyms, 25 on antonyms, and 20 on verbal analogies. It has a 20-minute time limit. Content specifically associated with science, mathematics, social studies, the humanities, and the arts is excluded since it is sampled in other parts of the MCAT.

The Quantitative Ability subtest consists of 50 items administered with a 45-minute time limit. Although most of these items are

presented as problems in arithmetic, elementary algebra, and geometry, the primary purpose of the test is to assess the ability to reason with numerical and quantitative concepts rather than to test for specific mathematical knowledge or achievement. The verbal content of the test has been held to a minimum in an attempt to achieve maximum independence from the Verbal Ability subtest, to achieve a relatively pure measure of quantitative ability, and to permit completion of the maximum number of items in the allotted time.

The General Information subtest is designed to give an indication of the applicant's breadth of knowledge in fields other than science and mathematics. This test was never intended to be a strong predictor of academic performance in medical school, but was included to emphasize the desirability of a broad premedical preparation not limited solely to the sciences. The test has 75 items and a 25-minute time limit. It samples from such fields as history, government, political science, economics, geography, sociology, anthropology, psychology, literature, philosophy, art, music, and even sports.

The Science subtest is typically the best of the four MCAT subtests as a single predictor of performance in the preclinical years of medicine, and it has the virtue of providing comparative information about achievement in science on a scale of measurement common for all applicants. While premedical science grades are quite valuable as predictors of medical school achievement, most admissions committees are regularly faced with the problem of attempting to evaluate the background of applicants coming from a diversity of colleges and universities and having widely differing undergraduate backgrounds. The Science subtest results can be of major assistance in this regard. The test has 86 items

and a 60-minute time limit. Approximately 50 percent of the items deal with chemistry, 35 percent with biology, and 15 percent with physics. The primary emphasis in the biology section is on zoology, but some items on botany are included; understanding of functions is stressed rather than knowledge of taxonomic details. The physics and chemistry items emphasize understanding of principles and problem solving rather than isolated bits of information. The chemistry items cover the range from general to organic chemistry, but the physics items tend to be at a fairly elementary level. More advanced physics items have been tried out experimentally but excluded from final test forms because too few of the applicants were able to answer them correctly.

All four subtests are power tests rather than speed tests. Each is designed so that nearly all applicants will have an opportunity to respond to all of the questions. The time limits are used primarily to achieve administrative uniformity, not to speed responses.

The MCAT consists entirely of four option, multiple choice items. Within each subtest, the questions are ordered from easiest to most difficult; they are not grouped by subject matter content. Some typical examples of MCAT items are included in the annual MCAT Announcement (6). These are intended primarily to provide the applicants with some idea of the nature and form of the questions comprising each subtest, and one should not attempt to generalize from these samples to the test as a whole.

Raw scores are obtained as simple counts of the number of items answered correctly, with no adjustment for wrong answers (sometimes referred to as "correction for guessing"). Raw scores are then

transformed into two types of derived scores for reporting purposes:

1. Scaled scores. These have a mean (arithmetic average) of 500, a standard deviation of 100, and a range from approximately 200 to 800. Scaled score transformations are based on the performance of some 12,500 individuals who took the MCAT in 1951. It is a common misconception that the subtests are renormed annually setting 500 as the mean. This is not so. Any given scaled score indicates a standard level of ability or achievement which is independent of the year in which it was earned. Mean scaled scores are computed for each testing period, however. These have been above 500 consistently since 1965, indicating higher average levels of ability and achievement than were present in the 1951 standardization group.

2. Percentile scores. These range from 0 to 99+ and indicate how a given individual's performance compares with that of others currently applying to medical school. Specifically, an individual's percentile score for a given subtest tells what percentage of those taking the MCAT in the same year did less well on that particular subtest: e.g., a person obtaining a percentile score of 70 on a given subtest has outperformed seventy percent of all other current examinees.**

Scores obtained on the MCAT, as on other such tests, are not fixed points. Due to the lack of precision of such tests as measuring instruments, a given three-digit scaled or standard score may be quite a few points away from a truly accurate indication of the person's ability. For instance, if an examinee receives a reported score of 500 on the Science subtest, one cannot be sure that his true score--i.e., the score he would obtain if the test were completely accurate--is exactly 500.

** Further information on these two types of derived scores, as well as others, can be found in introductory measurement textbooks; e.g., Thorndike and Hagen (7).

The observed score of 500 is the best estimate of the true score, but it might almost as easily be 490, or 510, and scores of 460, or 540, are by no means unreasonable estimates. Similarly, a percentile score is also an estimate, and percentile ranges known as bands are reported to emphasize this fact. MCAT percentile bands are calculated so that the chances are approximately 2 out of 3 that the reported band will include the individual's true score. Test users are also cautioned not to exaggerate the significance of small score differences between individuals. The larger the difference between the scores of two individuals on a subtest, the more confidence one can have that the difference is real and not merely apparent. There is no minimum difference above which such a difference can be regarded as real and below which it must be regarded as apparent; there is only a continuously increasing probability of a true score difference in the indicated direction as the observed score difference increases. However, as a rule-of-thumb: When reported scores of two examinees are being compared, a minimum difference of at least 35 to 55 scaled score points--depending upon the particular subtest under consideration--must exist before it can be said that one candidate may be more able than the other.***

Now, let us face the question, "What is the purpose of the MCAT?" A rather general answer is that the test is intended to provide admissions committees of medical schools with information about certain abilities of their applicants which may be used in conjunction with other information, such as that gathered from application forms, undergraduate records, recommendations, interviews, etc., in making

*** For a more complete discussion of these matters, the reader can refer to the Handbook for Admissions Committees (2nd ed.), pp. 19-20. (1)

decisions about acceptance or rejection. The MCAT also acts as a common yardstick or standard, giving estimates of abilities and knowledge that are free from variations due to regional and college differences. While true, this does not tell us too much about the specific aims with which the MCAT has been imbued by its designers and users. It is assumed that admissions committees first wish to select students who will be capable of successfully completing the course in their medical schools. It would be an obvious disservice to the applicants, the schools, the profession, and society in general to admit candidates who are unlikely to succeed while refusing scarce and coveted class openings to more promising applicants. This reasoning can be extended to focus on the necessity of mastering the first year or two of medical studies, because anyone failing to clear that level obviously will neither move on to later stages of the curriculum nor enter the profession. Hence, one important characteristic of the MCAT should be the ability to predict academic success, especially during the first year or two of medical school.

Evidence amassed in a study by Johnson and Hutchins (8) testifies strongly for the efficacy of the MCAT in distinguishing between medical school dropouts and those who continue on to become physicians. Studies at individual schools reflect the fact that the extent to which MCAT scores will predict medical school performance varies from school to school and to some extent from year to year within a given school. Since there are inter-school (and year-to-year) variations in the size and characteristics of the applicant pool, in the nature of the selection process, and in the standards of performance evaluation, it is not surprising to find that the reported accuracy of the MCAT or any other

predictor is far from uniform. A classic problem which plagues research on the predictive validity of the MCAT is the one of restriction of range due to selection. To the extent that the use of any selection device increases the uniformity of the admitted group, the power of the device to predict variation in subsequent performance is diminished.**** There is also in operation what might be referred to as a "hydraulic" effect. When other valid predictors strongly indicate probable success, principally undergraduate grades or premedical advisor's recommendations, admissions officials may likely and properly discount slightly inferior MCAT scores, and vice versa. Within a class containing such mixtures, the separate predictors cannot all prove to be highly accurate. Despite these and other obstacles, MCAT scores do provide a creditable gauge of academic success in medical schools. When compared with the more standard criterion of performance on the tests of the National Board of Medical Examiners, the MCAT scores, especially those in Science, show a stronger relationship than they do with medical school grades.

Prediction of academic success is not the sole aim of the MCAT program, however. If a test were to be designed with the single narrow purpose of maximum accuracy in forecasting first-year medical school grades, it might be well to abandon the present format and concentrate on experimenting with an extensive test in chemistry and biological science, well saturated with demands for factual knowledge and rote memory. The test might not be fair to able candidates with minimal backgrounds in these fields, and it surely would not reveal

**** A more complete discussion of these problems is also contained in the Handbook (1).

other characteristics desirable and necessary in the whole spectrum of the medical profession. Across the entire population of freshman medical students, however, it would probably do quite well in relating to class standing. But there is both a need and a desire to do more than just that with the total MCAT program. Promising students who have a broader background than mere specialization in these sciences should be given the opportunity to display their potential. Admissions committees who wish to assure some variety in the characteristics of their student bodies need to have before them a wealth of objective information about the characteristics and potentials of their applicants in order to exercise that intent. And it is more useful to those concerned with medical manpower that the MCAT program help predict which applicants will and will not complete the M.D. degree, and which medical specialties and types of practice the graduates are likely to enter, than it is that the MCAT can (or cannot) predict medical school grade-point average or rank in class.

Currently, medical schools have many more qualified applicants than they have places in their freshman classes. Although medical education is fortunate in many ways to have this situation, no one will envy the arduous task of making the selection decisions which must be made. Surely, all of the pertinent information about the applicants that it is feasible to provide should be provided, and the four subtests of the MCAT attempt to make a contribution in this direction. It follows that the lumping or averaging of the four subtest scores is discouraged since potentially valuable differential information is thereby masked and lost. If discrepancies arise among the four scores or among the scores and other data such as undergraduate grades, the MCAT provides

a potential service in bringing these differences to light and stimulating inquiry into their possible significance. If it merely raises such questions, then it provides a service. The ultimate function of the MCAT is to provide information which may help toward more objective and appropriate selection decisions than could be made in its absence; it is not intended to be a mechanistic screening device.

The MCAT is administered twice yearly, in May and October, at centers throughout the U.S. and at foreign centers throughout the world. (Because of increasing numbers of people taking the test, it may become necessary to add a third yearly administration.) Announcements describing the MCAT are distributed annually to undergraduate colleges and to medical schools. The announcement contains a list of testing centers and instructions as to how to make application to take the test. Once the applicant submits his application to take the test and the test administration fee, he is assigned to a testing center and receives an admission card for that center.

The tests are scored and score reports are sent to the medical schools and/or other agencies as requested by each examinee. Beginning with the May 1968 testing period, each student now receives two copies of his test report, one for himself and one for his premedical advisor. All score reports are accompanied by explanatory material. Score reports to both medical schools and examinees include percentile scores based on the performance of current examinees as well as the standard scores based on the performance of the group of students originally used in standardizing the test. In addition to supplying individual reports

of scores, a summary book of test scores for each testing period is supplied each medical school, along with periodic statistical summaries of various types.

As of January 1, 1970, the Division of Educational Measurement and Research of the Association of American Medical Colleges assumed responsibility for all test reports to schools and to examinees. This is being coordinated with the new American Medical College Application Service (AMCAS) and its parent division, the AAMC Division of Student Affairs. Test administration and scoring continue to be handled by The Psychological Corporation. The AAMC Division of Educational Measurement and Research is also responsible for all research related to the MCAT program, which will soon be facilitated by a central AAMC data bank containing complete medical student records. Behind these developments is renewed attention to all aspects of the MCAT program, and significant changes may be just around the corner.

FUTURE

Since the May 1968 administration of the MCAT, a questionnaire has been completed by each examinee. The purpose of this questionnaire is twofold: (a) To gather data on the educational backgrounds and career choices of the examinee population and subpopulations for use in research, and (b) to gather data on issues specifically relevant to possible modifications of the MCAT program.

One possible change under consideration for the future is that MCAT examinees may not be required to take the Verbal and Quantitative subtests if they have recently taken one or more tests in other contexts which measure essentially the same abilities. Tables of equivalent scores could be developed between these two MCAT subtests and other

tests such as the Miller Analogies Test, Graduate Records Examination, American College Testing Program, and the Scholastic Aptitude Test of the College Entrance Examination Board. Subsequently, MCAT Verbal and Quantitative subtests would need to be administered only to those candidates who either (a) had never taken one of the "equivalent" tests, or (b) desired to have a retest of these abilities. A feasibility study of this question must initially determine how many of the MCAT examinees have taken which standardized tests and when. These data are provided by the questionnaire.

No decision has been made concerning the future of the Verbal and Quantitative subtests; this is but a sample of the kinds of questions now being asked in conjunction with future planning for the MCAT program. Other questions, and perhaps more important ones, deal with the objectives of the MCAT. Are test results to serve the purpose of evaluating past learning or predicting future performance? Or are both functions desired, and, if so, to what degree? An answer implies the specification of content areas to be included either as optional or required parts of a future MCAT. Further, what part, if any, should non-cognitive variables such as might be obtained from biographical and personality measures play in such a program?

The answers to the questions raised, and to others, lie in an analysis of the admissions process and its objectives. It is also critical to consider curricular objectives and needs of medical education and the present trend toward a multi-track system. A subtle but absolutely crucial consideration is the tremendous state of flux now characterizing medical education, and explained in part by current

attempts to define the types of medical personnel needed to satisfy society's demand for the improved delivery of health care.

The purpose of the foregoing remarks is to underscore the tremendous complexity involved in planning a program of testing to serve the needs of admissions officers. Not only must the planners be in possession of all available evidence related to the selection process today, but they must project what the corresponding information would recommend when any instruments to be developed would be available for implementation. These observations should not be interpreted as an advance rationalization or apology for inactivity. On the contrary, the AAMC is deeply committed to improving its testing programs. Rather, such remarks are intended to emphasize the necessarily tentative nature of current thinking, and the necessity of developing plans which will accommodate to changes as they occur in the medical education process. With these caveats as background, the nature of present thinking can be indicated more specifically.

Present answers to some of the questions posed recommend increasing the emphasis in the MCAT program on the evaluation of pre-medical achievement through expanding the science portion of the test. More and more pass-fail grading in pre-medical courses is one of the reasons. An expanded science portion should be understood to imply not only the possibility of specific subtests in the medically-related basic sciences but also the possibility of subtests in the medically-related behavioral sciences as well. Various of these subtests might be optional, depending upon what curricular track the examinee hopes to enter. A related alternative would be an integrated test with separate scoring keys. Regardless of the method, the result should be an

appropriate profile of pre-medical achievement presented most efficiently to medical school admissions officers.

The possibility of even rather extensive changes in test content does not imply the exclusion of proven correlates of academic performance during the first year or two of medical study. Measures of verbal and quantitative ability would be available in one form or other. In addition, possible predictors of clinical performance should be investigated for inclusion. Such variables would likely involve general or specific problem solving, communications, biographical, and personality-related measures.

The pre-medical school achievement profile provided by a future MCAT having some of the characteristics described above would be supplemented by the simultaneous development of a program of special achievement or "placement" tests. These tests would be available to carry one step further the individualized curriculum planning for the entering student. This program has already been initiated with the fall 1970 administration of the AAMC Biochemistry Placement Test.

A Committee on the Measurement of Personality has been formed to define the purpose and function of personality-motivation assessment in the overall medical school admissions process, as well as in the evaluation of student performance. Newer measurement methodologies are being studied in addition to standard personality inventories and techniques. The probability of developing something useful in this difficult measurement area may not be great, but the payoff from doing so would be great indeed. A new kind of objective information would be made available to admissions committees to be compared with

the more subjective impressions gained from recommendations and personal interviews.

As implied earlier, a great deal of attention will also need to be given to developing improved criterion measures: measures of medical student and physician performance. Future years will undoubtedly see an increase in research with the multiple discriminant model in which meaningful categories such as doctor vs. dropout, and meaningful choices such as medical specialty and type of practice, will replace medical school grade point average and National Board scores as the criterion variables, i.e., the measures to be predicted. In addition, it seems likely that medical schools will increasingly use objective information gained from the MCAT program for selecting students with diverse backgrounds, and for helping to plan and implement individualized programs of medical education.

In the meantime, research is underway on the MCAT as it now exists to assure that the test does not deal unfairly with examinees from minority groups, and all aspects of the MCAT program continue to be scrutinized by an advisory board of prominent medical educators.

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