Moderator: Lee Manchul, MD

Discussant: Eric Holmboe, MD

Predicting Clinical Performance: Does the Medical College Admission Test Predict Clinical Reasoning Skills? A Longitudinal Study Employing the Medical Council of Canada Clinical Reasoning Examination

Claudio Violato and Tyrone Donnon

Abstract

Background
To investigate the predictive validity of the Medical College Admission Test (MCAT) for clinical reasoning skills upon completion of medical school.

Method
A total of 597 students (295 males, 49.4%; 302 females, 50.6%) participated from 1991 to 1999. Stepwise multiple regressions of the MCAT and premedical school GPA (independent variables) on the Part 1(declarative knowledge) and Part 2 (clinical reasoning) of the Medical Council of Canada Examinations (dependent variables) were employed.

Results
For Part 1, the multiple regression revealed that three predictors (verbal reasoning, biological sciences, GPA) accounted for 23.3% of the variance, and for Part 2, two predictors (verbal reasoning, GPA) accounted for 11.2%.

Conclusion
There is both convergent and divergent evidence for the predictive validity of the MCAT for clinical reasoning.

Acad Med. 2005; 80:S1–S1.

The predictive validity of the Medical College Admissions Test (MCAT) for measures in undergraduate medical education, stages of the United States Medical Licensing Examinations (USMLE) (Steps 1, 2, and 3), Medical Council of Canada Examinations (MCCE), and other criteria continues to be an important issue notwithstanding the substantial research that has been conducted.[1,2] The MCAT is intended to predict the ability to acquire knowledge throughout the formal medical education years, and also to assess higher-order processes such as clinical reasoning and the application of knowledge into clinical practice. Accordingly, the MCAT is presumed to not only measure biological and physical sciences knowledge, but also attempts to assess higher order cognitive processes such as verbal reasoning, writing ability, and critical thinking. The major purpose of the present study was to further explore evidence for the predictive validity of the MCAT on clinical reasoning skills.

The development of the MCAT arose not only from concern over the high attrition rates in medical schools throughout the United States in the early 20th century, but also as a result of developments in fields such as scientific psychology where emphasis was placed on mental measurement and individual differences in performance.[3] The initial focus was on designing a reliable and valid measurement instrument that would aid in selection and also produce estimates of future success. That is, it was expected that the MCAT should have predictive validity.

Crowder[4] studied the predictive validity of an early version of the MCAT and undergraduate science scores on first-year medical school performance and found that the MCAT science section was the best single predictor. Furthermore, the combination of GPA science grades and the MCAT science subsection added even greater predictive power to first-year medical school performance. This finding was corroborated by Roemer[5] with a second version of the MCAT. He found that science and quantitative subscales of the MCAT and undergraduate GPA correlated with medical school performance in the first, second, third, and to a lesser degree, fourth year. These early studies, however, were limited to single institutions and focused on early performance as the criterion variables (i.e., medical school performance).

Shaw et al,[6] employing the third version of the MCAT, found that Verbal, General Information, Quantitative, Science, and Total scores significantly predicted performance on Part II of the National Board Examination (currently the USMLE Step 2). Other studies[7,8] have also found that MCAT scores correlate with USLME Step 1 and its predecessor, National Board of Medical Examiners Part 1 (multiple correlations between .39 and .63).

Since the revision to the MCAT in 1991, research has been undertaken to adduce validity evidence for the MCAT's ability to predict undergraduate test scores, medical school performance, and USMLE scores as well as other criteria of performance. Basco et al,[9] for example, reported that undergraduate science GPA and MCAT scores (specifically biological, physical, and verbal subscales) were

Correspondence: Claudio Violato, PhD, Director, Medical Education and Research Unit, Faculty of Medicine, Department of Community Health Sciences, 3,330 Hospital Drive NW, University of Calgary, Calgary Alberta, Canada T2N 4N1; e-mail: ⟨violato@ucalgary.ca⟩.

balt1/zvk-acm/zvk-acm/zvk11005/zvk0125-05a | henrys | S=9 | 7/28/05 | 13:38 | Art: ACM200046 | Input-nlm

Table 1

Stepwise Multiple Regression of the Medical College Admission Test (MCAT) and Grade Point Average with Medical Council of Canada)(MCC) Exams Part 1 and Part 2 (n=597)

MCC Part 1 – Declarative Knowledge	Multiple *R*	R^2	Beta (β)	*t*	*p*
MCAT subtests					
Verbal Reasoning			.258*	6.578	
Physical Sciences			–.032	–0.693	
Biological Sciences			.192*	4.186	
Writing Sample			–.029	–0.784	
Undergraduate grade point average			.293*	7.714	.000
Total model	.482*	.233*		7.745	.000
MCC Part 2 - Clinical Reasoning Skills					
MCAT subtests					
Verbal Reasoning			.241*	5.714	
Physical Sciences			.018	0.350	
Biological Sciences			.034	0.681	
Writing Sample			–.006	–0.147	
Undergraduate grade point average			.191*	4.683	.000
Total model	.335*	.112*		6.126	.000

* $p < .0001$.

predictors of preclinical licensure performance as measured by the USMLE Step 1. The MCAT as a single variable is considered to be a predictor of performance[1,9,10–12] of undergraduate medical school courses and Steps 1, 2, and 3 of the USMLE. Additionally, when the MCAT is combined with undergraduate GPA the predictive power in estimating outcome criteria (i.e., medical school scores and USMLE scores) is further improved.[10,11]

The MCAT also appears to have some predictive validity of those competencies in the clerkship years that may involve higher-order cognitive processes beyond those assessed by pencil-and-paper tests. Indeed, results from one study employing multiple regression techniques[12] concluded that MCAT scores alone explained approximately 20% of the variance in clerkship performance and further increased predictive validity coefficients when other preadmission variables (i.e., undergraduate GPA) were added to the equation.

Although the predictive validity of the MCAT has been shown to decrease in the clinical years of study,[13] there is a common theme throughout undergraduate and postgraduate medical education that includes important aspects of a construct—aptitude for medicine—assessed by the MCAT. In a recent meta-analysis[2] of the published research on the predictive validity of the MCAT, it was found that validity coefficients ranged from .25 to .60 for a variety of criterion measures of performance (e.g., USLME, clerkship performance). Nevertheless, further research is required to clarify the magnitude of the predictive validity coefficients especially for higher-order cognitive processes such as clinical reasoning. The primary purpose of the present study, therefore, was to investigate further the predictive validity of the MCAT for clinical reasoning. Specifically, we conducted stepwise multiple regression analyses of the MCAT and GPA for predicting performance on the Medical Council of Canada clinical reasoning and declarative knowledge examinations.

Method

There were 597 participants (295 males, 49.4%; 302 females, 50.6%) in the present study that had been admitted to a Canadian medical school from 1991 to 1999. Approximately 65 candidates were admitted each year during this period. Data were collected on the MCAT subtests (Verbal Reasoning, VR; Biological Sciences, BS; Physical Sciences, PS; Writing Sample, WS), full undergraduate GPA on admission and, subsequently, the MCCE declarative knowledge (Part 1) and clinical reasoning subtests (Part 2). The Medical Council of Canada examinations are written after completion of the medical degree.

Part 1 (declarative knowledge) consists of seven sections (e.g., pediatrics, psychiatry, medicine) each with 28 multiple choice questions for a total of 196 items administered during 3.5 hours. Part 2 (clinical reasoning skills) consists of up to approximately 60 cases with one to four questions each, for a total of approximately 80 questions. The test is designed to assess problem solving and clinical decisions with either short-menu or write-in questions administered during four hours.[14]

Scores on Part 1 and Part 2 of the MCCE were used as dependent variables (DV) and MCAT subtests and GPA were used as independent variables (IV) in separate stepwise multiple regression analyses. The study received approval from the Conjoint Health Research Ethics Board of the University of Calgary.

Results

Over the period 1991–1999, the mean GPA on a four-point scale for the admitted students was 3.43 (SD = .35), while the MCAT subtest means were VR = 9.57 (1.70), BS = 10.38 (1.95), PS = 10.13 (1.95), and WS = 10.22 (1.76; the letter values J-T were converted to numerical equivalents [J = 3, K = 4, . . . T = 13] for the analyses). For the MCC Part 1 (declarative knowledge), the mean was 524.86 (76.44) and for Part 2 (clinical reasoning) the mean was 521.65 (77.16).

The results of the stepwise multiple regression analyses are summarized in Table 1. In the upper part of Table 1, it can be seen that two of the MCAT subtests significantly correlate with Part 1 of the MCC (VR: $\beta = .258$, $p < .001$; BS: $\beta = .192$, $p < .001$) while two do not (PS and WS). GPA has the largest relationship to Part 1 of any of the IVs (GPA: $\beta = .293$, $p < .001$). The total model (GPA, VR and BS) produce a multiple *R* with the MCC Part 1 = 0.482 ($p < .001$) accounting for 23.3% of the variance (Table 1).

In the lower part of Table 1, it can be seen that only one of the MCAT subtests significantly correlate with Part 2 (clinical reasoning) of the MCCE (VR $\beta = .241$, $p < .001$) while three do not (BS, PS and WS). GPA also correlates to Part 2 (GPA

$\beta = .191$, $p < .001$). The total model (VR and GPA) produces a multiple R with the MCCE Part 2 of .335 ($p < .001$) accounting for 11.2% of the variance (Table 1). Comparing and contrasting the two regression models, it is evident that the model for Part 1 of the MCC accounts for twice as much of the variance as does the model in Part 2. A close inspection of β in Table 1 shows that while the BS is significant as an IV in the first model, it is not in the second model.

Discussion

The main findings of the present study are that (1) a regression model employing MCAT VR and BS together with GPA significantly predicts performance on Part 1 of the MCCE, (2) a regression model employing MCAT VR and UGPA significantly predicts performance on Part 2 of the MCCE, and (3) the models differ in the magnitude of the variance accounted for, the IVs that are included, and the magnitude of β in the included IVs.

The regression results for Part 1 of the MCCE are consistent with a number of other studies[2,7,8] for the MCAT subtests included and the magnitude of the multiple correlation and variance accounted for. Part 1 measures primarily declarative biomedical knowledge in a multiple-choice format that is similar to the BS form of the MCAT. Verbal Reasoning on the MCAT is likely a proxy measure of verbal intelligence and is also related to Part 1, as is GPA. These results provide evidence for the predictive validity of the MCAT for performance on Part 1 of the MCCE.

The regression results for Part 2 of the MCCE reveal that only VR from the MCAT and GPA are related to performance. Part 2 measures clinical reasoning employing menu-type items and constructed response-type items. Accordingly, both the measurement method (multiple-choice questions versus menu and constructed response) and cognitive processes measured (declarative knowledge versus clinical reasoning) are different on the MCAT and Part 2 of the MCCE. It is not surprising, therefore, that the subtests of MCAT that employ multiple-choice questions and declarative knowledge are unrelated to performance. Nonetheless, VR is related to performance providing evidence of the predictive validity of this subtest for clinical reasoning.

Comparing and contrasting the two regression models provides both convergent and divergent evidence for the predictive validity of the MCAT for clinical reasoning. In the first model where a declarative knowledge measure is employed as the dependent variable, congruent measurement of the independent variables (multiple-choice questions of declarative knowledge) results in a model that accounts for twice a much variance than for the second model (23.3% versus 11.2%). In the second model, where the dependent variable is clinical reasoning, the multiple-choice question measure (BS) that assesses declarative knowledge is excluded from the regression equation. The remaining MCAT independent variable is VR that assesses reasoning that is also tapped in Part 2 of the MCCE. GPA figures in both models although it does more so (larger β) in the model with declarative knowledge as the dependent variable.

Neither the WR nor the PS subtests of the MCAT are included in either regression model. This result is in concordance with several other studies[2] where these two subtests, especially WR, fail to add incremental predictive validity in regression analyses. Results for the PS are less consistent and sometimes it does contribute incremental predictive validity in regression analyses.[2]

There are two limitations of the present study. First, the results are based on data from only one medical school. The present study should be replicated with other samples. Second, the construct validity of Part 2 of the MCCE as a measure of clinical reasoning is not well established and requires further research. Notwithstanding these concerns, the present results do provide some evidence for the predictive validity of the MCAT for clinical reasoning skills.

References

1 Albanese MA, Snow MH, Skochelak SE, Huggett KN, Farell PM. Assessing personal qualities in medical school admissions. Acad Med. 2003;78:313–21.

2 Donnon T, Violato C, Oddone E. Predictive validity of the MCAT: a meta-analysis of the published research. Paper presented at the 11th International Medical Education Ottawa Conference, Barcelona, Spain, July 4–8, 2004.

3 McGaghie WC. Assessing readiness for medical education: Evolution of the Medical College Admission Test. JAMA. 2002;288: 1085–90.

4 Crowder DG. Prediction of first-year grades in a medical college. Educ Psych Meas. 1959; 19:637–39.

5 Roemer RE. Nine year validity study of predictors of medical school success. Educ Psych Meas. 1965;59:183–85.

6 Shaw DL, Randels PM, Elson P. Does MCAT predict clinical performance? J South Carolina Med Assoc. 1979;75:371–74.

7 Mitchel KJ. Traditional predictors of performance in medical school. Acad Med. 1990;65:149–58.

8 Vancouver JB, Reinhart MA, Solomon DJ, Haf JJ. Testing for validity and bias in the use of GPA and the MCAT in the selection of medical school students. Acad Med. 1990;65: 694–96.

9 Basco W, Way D, Gilbert G, Hudson A. Undergraduate institutional MCAT scores as predictors of USMLE Step 1 performance. Acad Med. 2002;77(10 suppl):S13–15.

10 Anonymous. The predictive validity of the Medical College Admission Test. Association of American Medical Colleges. Contemp Issues Med Educ. 2000; 3(2).

11 Wiley A, Koenig J. The validity of the Medical College Admission Test for predicting performance in the first two years of medical school. Acad Med. 1996;71(10 suppl):S83–85.

12 Veloski J, Callahan C, Xu G, Hojat M, Nash D. Prediction of students' performances in licensing examinations using age, race, sex, undergraduate GPA, and MCAT scores. Acad Med. 2000;75 (10 suppl):S28–30.

13 Silver B, Hodgson C. Evaluating GPAs and MCAT scores as predictors of NBME 1 and clerkship performance based on students' data from one undergraduate institution. Acad Med. 1997;72:394–96.

14 Medical Council of Canada. The Objectives for the Qualifying Examination, 2nd ed. Ottawa: Medical Council of Canada, 1999.

AUTHOR QUERIES

AUTHOR PLEASE ANSWER ALL QUERIES **1**