

Standardized Test Scores as an Admission Requirement

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OBJECTIVE: The usefulness of standardized test scores as an admission requirement for the University of Washington Medical Technology Program (UWMTP) was evaluated. Scores from the Allied Health Professions Admissions Test (AHPAT) were used.

DESIGN: Student data (n = 183) were analyzed and evaluated statistically using Pearson correlation and Cox proportional hazards regression analyses. Sensitivity and specificity for several admissions criteria were calculated.

SETTING: The UWMTP is a 2 + 2 medical technology program (MTP) located in a large public university.

PARTICIPANTS: Student records for classes of 1993 through 2000 were reviewed. Eligibility for inclusion was based on completeness of student record.

MAIN OUTCOME MEASURES: Several admission criteria were analyzed for their ability to predict success in the UWMTP and on the ASCP Board of Registry (BOR) certification examination, and for their sensitivity and specificity.

RESULTS: Pearson correlations for the AHPAT total score were $r = 0.402$ with the MTP GPA and $r = 0.414$ with the BOR exam. Cox proportional hazards regression analysis defined the decreased likelihood of failure for each unit increase in the test score. For the MTP GPA, the risk decrease was 0.8% for the AHPAT total and 2.8% for the Biology subtest. For the BOR exam, the risk decrease was 0.8% for the AHPAT total and 2.8% for the Verbal subtest. The admissions criteria selected based on specificity (26.7%) and maximum sensitiv-

ity (100%) was one in which the student must achieve at least two of the following three scores: AHPAT total 150, Biology subtest score 10, Verbal subtest score 5.

CONCLUSIONS: Scores on a standardized test can be used to predict success in a MTP and on the ASCP BOR exam.

ABBREVIATIONS: AHPAT = Allied Health Professions Admission Test; BOR = American Society of Clinical Pathology Board of Registry exam; Cox = Cox proportional hazards regression; Cum GPA = cumulative GPA; FN = false negative; FP = false positive; GPA = grade point average; MTP = medical technology program; NCA = National Credentialing Agency for Laboratory Personnel; Sci GPA = science GPA; Sn = sensitivity; Sp = specificity; TN = true negative; TP = true positive; UWMTP = University of Washington Medical Technology Program

INDEX TERMS: aptitude tests; college admission test; school admission criteria; student selection.

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Clinical laboratory science/medical technology programs, like other limited-admission educational programs, are faced with the challenge of identifying which applicants will successfully complete the course of studies. The ability to predict student success in any given field of study would be ideal, however no single measure of success has been identified. The University of Washington Medical Technology Program (UWMTP) has experienced an increase in applicant num-

bers in the last three years, resulting in a greater need to discriminate between applicants. Even in times of lower applicant numbers the admission of students who ultimately fail wastes time and valuable resources, and graduating inferior students devalues alumni and the profession.

Typical admission criteria for many allied-health programs include standardized test scores, grade-point average (GPA) from high school or prior college, interviews, letters of recommendation, and personal essays.¹⁻⁶ There are few standardized tests available that are specifically targeted to science or health-related professions at the bachelor's level. The Allied Health Professions Admission Test (AHPAT), administered by The Psychological Corporation (San Antonio TX), is intended to be used as a tool in ranking applicants for a variety of health related programs including clinical laboratory science/medical technology.⁷ Raw and percentile scores are reported for each of five subsections, including verbal ability, biology, chemistry, quantitative ability, and reading comprehension.

The UWMTMP uses five items for ranking applicants to its 2+2, University-based program. The items include cumulative GPA (Cum GPA) earned at all previous universities and colleges, science GPA (Sci GPA) calculated only from selected prerequisite courses, letters of recommendation, a personal interview, and scores from the AHPAT. The UWMTMP has required applicants to submit scores from the AHPAT for more than fifteen years, and has used the sum of all five percentile scores as one of the criteria for ranking applicants. Previously the correlation between the AHPAT scores and the students' success in the UWMTMP or on the national certification exams was unknown. Additionally, neither the sensitivity (Sn) and specificity (Sp) of the arbitrarily assigned minimum value of 100 for the total score, nor the Sn and Sp of other possible criteria have been calculated or evaluated.

METHODS

Database

The data were obtained from a thorough review of student records from the graduating classes of 1993 through 2000. Exclusion criteria included incomplete records or failure to complete the program due to withdrawal for personal reasons. Data from students who were dismissed from the program due to low scholarship were included in the database and counted as program failures. If a dismissed student was later readmitted to the program, the readmission data was not included, regardless of outcome. The following items were recorded (n = 183 unless otherwise noted): coded study number, pre-admission Sci GPA (n = 180), Cum GPA,

AHPAT total and subsection scores, grades in each required class during the two years in the medical technology program (MTP) (including courses taught outside the Department of Laboratory Medicine), an MTP GPA calculated from required courses, and first-time scaled scores for the American Society of Clinical Pathology Board of Registry (BOR) (n = 157) and/or National Credentialing Agency for Laboratory Personnel, Inc (NCA) exams (n = 22). Repeat BOR or NCA exam scores were not included.

Pearson correlation and Cox proportional hazards regression

A Pearson correlation between the outcomes measures (MTP GPA, BOR, NCA) and predictors (Sci GPA, Cum GPA, AHPAT total, AHPAT subsection scores) was performed. Z-scores (student score-mean score/standard deviation of scores) were used when comparing measures on two different scales, such as the AHPAT, which reports percentiles from 1 to 99, and MTP GPA.

A Cox proportional hazards regression analysis (Cox) was also performed, using SPSS Advanced Statistics 7.5 (SPSS Inc, Chicago IL). The Cox statistic was originally applied to survival studies, where the endpoint of the study was death of a subject.⁸ However it can be applied to other circumstances in which the significance of several predictors on a single outcome is desired, and in which the data is censored. Censored data is defined as a data set in which some observations are terminated before others, i.e., some students are dismissed from the program and are not observed for the full seven quarters of the UWMTMP. One of the mathematically derived parameters is the relative risk of failure resulting from an increase of one unit in one of the predictors. In this study the unit increases in predictors are a one percentile increase in AHPAT total or subsection score, or an increase of 0.01 in the Sci or Cum GPA. The percent decrease in risk of failure represents the decreased likelihood that a student who achieves a particular score will fail either the UWMTMP or the BOR.

For the determination of the significance of the predictors, the outcome is defined as 0 or 1, in which 0 is completed UWMTMP or passed the BOR on the first attempt and 1 is failed UWMTMP or failed the BOR on the first attempt. The model can be used in a forward stepwise fashion in which it considers each predictor separately and in combination, adding them one at a time and recalculating the significance. A predictor with a p value of <0.05 is considered to be significant. Once a significant predictor is added to the model, each remaining predictor is re-evaluated for significance against the new model before being introduced.

Table 1. Definitions used for calculating sensitivity and specificity

Parameter	Outcome measures	Status under proposed criteria
True positive	Passed both MTP and BOR	Admitted
True negative	Failed either MTP or BOR	Not admitted
False positive	Failed either MTP or BOR	Admitted
False negative	Passed both MTP and BOR	Not admitted

Sensitivity and specificity

Sensitivity (Sn) and specificity (Sp) are calculated using the following definitions of true positive, false positive, true negative, and false negative (see Table 1). True positive (TP) was defined as a student who succeeded in passing both the MTP and the BOR, and would have been admitted under the new criteria. True negative (TN) was defined as a student who either was dismissed from the MTP for low scholarship or failed the BOR on the first try, and who would not have been admitted under a proposed criteria. False positive (FP) was defined as a student who failed either the MTP or the BOR, and who would have been admitted under a proposed criteria. False negative (FN) was defined as a student who passed both the MTP and the BOR, and who would not have been admitted under the proposed criteria. The Sn (TP/TP+FN) and Sp (TN/TN+FP) of every possible AHPAT total score, biology subtest score, and verbal subtest score were determined for both MTP GPA and BOR score. The reading comprehension, chemistry, and quantitative ability subtests did not prove to be significant predictors of success using the Cox analysis, therefore Sn and Sp were not calculated for these subtests. The low number of NCA results made the sample too small for use in this part of the study.

Using these Sns and Sps as guidelines, multiple admission criteria were created. Sn and Sp were calculated for each of the criteria. The criteria consisted of combinations of the following limits: a total of either 100 or 150 for the AHPAT total; no minimum score, or a score of 5 on the verbal subsection; no minimum score or a score of 10 on the biology subsection.

HUMAN SUBJECTS REVIEW

This study was approved by the University of Washington Human Subjects Division.

RESULTS

Pearson correlations

Pearson correlation was used to measure the degree to which a linear relationship occurred between the two variables. When

the AHPAT Z-scores were compared to all three outcome measures, the correlation coefficients were considerably higher than any correlation between the other two predictors and the outcome measures (Table 2). The AHPAT score correlated best with the NCA score ($r = 0.794$), and not as well with the MTP GPA ($r = 0.402$) and the BOR score ($r = 0.414$). The Cum GPA correlated weakly with all three outcomes: MTP GPA $r = 0.329$, BOR $r = 0.296$, NCA $r = 0.334$. The Sci GPA was similar to the Cum GPA in correlation: MTP GPA $r = 0.368$, BOR $r = 0.298$, NCA $r = 0.288$. Due to the low number of NCA exam results in the database ($n = 22$), those correlation coefficients may not be reliable.

Cox proportional hazards regression analysis

When evaluating Cum GPA, Sci GPA, and the AHPAT total score against program status (completed or failed to complete UWMTP), the AHPAT was the only parameter that was significantly predictive of risk of failure (Table 3). The relative risk, which is determined mathematically as part of the Cox analysis, is that for each percentile increase in AHPAT score, there is a 0.8% decrease in the risk of failure

Table 2. Pearson correlation coefficients (r)

Predictors	Outcome measures		
	MTP GPA* (n = 183)	BOR† (n = 157)	NCA‡ (n = 22)
AHPAT§	0.402	0.414	0.794
Cum GPA+	0.329	0.296	0.334
Sci GPA#	0.368	0.298	0.288

* Medical Technology Program GPA

† ASCP Board of Registry Scaled Score

‡ National Certifying Agency for Medical Laboratory Personnel Score

§ Allied Health Professions Admissions Test

+ Cumulative pre-admission grade-point average

Pre-admission science grade-point average

in the program. When AHPAT subsections were evaluated on the basis of program outcome, the biology subsection was the most significant, with a 2.8% decrease in risk of failure for each unit increase in score (Table 4). Although the initial analysis showed the chemistry and reading comprehension subsections to have a significant influ-

ence, once the sections were considered in stepwise fashion, with the biology section added first, none of the other sections maintained significance.

Using BOR pass/fail as the outcome, the results differed only in which AHPAT subsection was most significant (see Table 4). The AHPAT was

still the only significant predictor when compared with Sci GPA and Cum GPA. For the AHPAT subsections, the verbal section became more significant than the biology section (Table 5).

Sensitivity and specificity

Scores used in the admissions criteria schemes were selected based on the desire to eliminate the greatest number of failures, while eliminating the least number of successes. Based on calculations of Sn and Sp for all possible criteria, scores of ten or no minimum for the biology subsection, five or no minimum for the verbal subsection and either 100 or 150 for the AHPAT total were selected for the seven schemes shown in Table 5.

The scheme that eliminated the fewest successes (Sn) while also identifying the most failures (Sp) was one in which the applicant must exceed two of the following three scores: AHPAT total of 150, biology score of 10, and verbal score of 5. Sn for this scheme was 100% and Sp was 26.7%. When applied to the database, no students who succeeded would have been eliminated, while only five of thirteen failures would have been admitted. While other criteria would have eliminated more of the failures (higher Sp), they would have also eliminated some of the successes.

DISCUSSION

This study was undertaken for the purpose of improving the selection criteria used to rank applicants to the UWMT. Admission selection criteria have been evaluated many times over the years, as educators search for better ways to differentiate between students likely to succeed and those likely to fail. Over the past 20 years, schools and programs ranging from clinical laboratory science,^{4-7,9} to medical school,¹⁰ physical therapy,^{1-3,7,9,11,12}

Table 3. Cox proportional hazards regression analysis for Cum GPA, Sci GPA and AHPAT total

Predictor	Significance for program status* (<i>p</i> value) [‡]	Significance for BOR status [†] (<i>p</i> value)	Decrease in risk of failure
Cum GPA	0.448	0.989	None
Sci GPA	0.641	0.208	None
AHPAT	0.001	0.002	0.8% for program and BOR

* Program status is defined as completed program or dismissed from program

† BOR status is defined as pass or fail on the first try

‡ *p* is significant at <0.05

Table 4. Cox proportional hazards regression analysis for AHPAT subsections

Predictor	Significance for program status* (<i>p</i> value) [‡]	Significance for BOR status [†] (<i>p</i> value)	Decrease in risk of failure
Verbal ability	0.877	0.004	2.8% for BOR only
Quantitative ability	0.255	0.967	None
Biology	<0.001	0.400	2.8% for program only
Chemistry	0.512	0.542	None
Reading comprehension	0.721	0.362	None

* Program status is defined as completed program or dismissed from program

† BOR status is defined as pass or fail on the first try

‡ *p* is significant at <0.05

occupational therapy,^{1,2,11,12} and health information management^{1,2} have evaluated their admissions criteria, sometimes with conflicting results.

A potential disadvantage of using GPAs is that it can be difficult to decipher the meaning of grades assigned at different colleges and universities due to differences in grading scales, issues of grade inflation, and questions about the meaning of grades earned five or more years previously. At the UWMTP, over the past ten years approximately 30% of the accepted students were transfer students. Although this information was not collected for this study, it is known that in most years, the program has had returning students with transcripts dating from more than five years prior to application. Using scores from a standardized test, taken within one year of application, helps in the assessment of students with older transcripts and in comparing students with transcripts from different institutions.

Analysis of our data by both Pearson correlation (Table 2) and Cox proportional hazards regression analyses (Table 3) showed that the AHPAT total score was a better predictor of success than either Cum GPA or the Sci GPA. Previous papers evaluating the AHPAT are mixed: two studies^{11, 12} showed no added value to AHPAT scores, while three studies^{7,9,13} showed that the AHPAT total or subsection scores were useful. These studies are all more than 20 years old and demographic information about the students is not provided for any of these studies. In our specific setting, the number of transfer and returning students is high enough to question the validity of GPAs earned at other institutions and more than five years in the past. This may contribute to the positive results found in this study.

Calculating the significance of the AHPAT subsections further refined the predictive ability of the AHPAT in our setting (Table 4). We found that the biology subsection was the only one that retained significance for program outcome, perhaps indicating the necessity for a solid understanding of biology as the foundation for the scientific body of knowledge that we teach. We also found that the verbal subsection was the only significant predictor for success on the BOR, perhaps indicating the greater influence of English language skills in a testing format with no laboratory component. In the UWMTP, written test scores are an important measure of success, but laboratory exercises, practical exams, and clinical performance evaluations are also important components. In addition, communication is both verbal and written, and there is opportunity to ask for clarification of exam questions, unlike the certification exams.

In order to create a practical scheme to be used to rank applicants, it was necessary to calculate Sn and Sp for AHPAT total and subsection scores. The practical interpretation of a criterion with high sensitivity is that fewer students who ultimately succeeded would have been denied admission. The interpretation of a criterion with high Sp is that more students who ultimately failed would have been denied admission. Therefore, the ideal criteria would have 100% Sn (maximum TP and TN) and 100% Sp (minimum FP and FN). However, no criteria achieved that. The general increase in Sp and decrease in Sn means that as an increasing number of failures would be eliminated, an increasing number of successes would also be eliminated. The cost of not admitting students likely to succeed seemed higher than that of admitting a few more students likely to fail, so the selected criteria does not have the highest Sp. The criteria that were chosen as the most desirable was one in which the applicant must achieve two of the following three scores: AHPAT total 150, Biology 10, Verbal 5. Setting the criteria as two out of three allows the students to do poorly in one section of the AHPAT, but not in all sections. The reading comprehension, quantitative ability, and chemistry subsections are reflected in the total score. Despite the low minimum scores, when applied to the database, eight students who failed the UWMTP ($n = 6$) or the BOR ($n = 2$) were identified, and no successful students would have been eliminated (Table 5). Four students who ultimately failed either the MTP or the BOR would have been admitted. These admission criteria have now been adopted by the UWMTP.

CONCLUSION

Faced with increasing applicant numbers, it is desirable to identify applicants who are most likely to succeed. Using a standardized test as one of several admission criteria can help evaluate students who have come from a variety of different colleges and universities, as well as students who are returning to school after time in the work force. The AHPAT appears to be a good predictor of success in the UWMTP and on national certification exams. The identification of the biology subsection of the AHPAT as the most predictive of program completion demonstrates that a good foundation of general biological science is necessary for success in the UWMTP. The impact of the verbal subsection on first-try success on the BOR underscores the level of English language skills necessary. It also points to the probable benefit of using exam questions formulated to mock certification exam questions to improve the students' test-taking skills. Using a two out of three approach allows students to do poorly on some subsections of the AHPAT, but not on all subsections. In addition to the AHPAT, other tests may exist or could be

designed for use in assessing applicants to allied health programs.

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Table 5. Sensitivity (Sn) and specificity (Sp) for selected admission criteria

Criteria	Sn (%)	Sp(%)	Failures eliminated	Successes eliminated	Failures admitted
2 of 3:					
AHPAT 150					
Biology 10	100.0	26.7	8	0	4
Verbal 5					
AHPAT 100					
Biology none	98.6	6.7	2	2	10
Verbal none					
AHPAT 150					
Biology none	97.9	30.0	9	3	3
Verbal none					
AHPAT 100					
Biology 10	97.9	20.0	6	3	6
Verbal none					
AHPAT 150					
Biology 10	97.2	30.0	9	4	3
Verbal none					
AHPAT 100					
Biology 10	95.8	36.7	11	6	0
Verbal 5					
AHPAT 150					
Biology 10	95.1	40.0	12	7	0
Verbal 5					