Determining admission criteria that will predict successful student outcomes is a challenging undertaking for newly established health professional programs. This study examined data from the students who entered a medical radiation sciences program in September 2002. By analyzing the correlation between undergraduate GPA, grades in undergraduate science courses, performance in program coursework, and post-graduation certification examination results, the authors determined admission criteria that were linked to successful student outcomes for radiological technology and radiation therapy students.

Methods

This study examined data from the 122 students who entered the University of Toronto/Michener Medical Radiation Sciences Program in September 2002. The length of the program is 3 yrs. At the completion of the program, the students receive a BSc in Medical Radiation Sciences and a diploma of Health Sciences. This joint BSc degree/diploma program was established in 1999 and educates students in the disciplines of radiological technology (RT), nuclear medicine (NM), and radiation therapy (RTT).

Students who entered in 2002 were required to complete four semesters of classroom and laboratory-based course
work (didactic program) and three semesters of clinical training. There were 11 courses common to all three disciplines, 1 course in common with two of the three disciplines, and 13 discipline-specific courses for RT and RTT and 12 for NM. Following completion of the program, the students challenged a 6-hr multiple choice national certification examination for Canadian practice eligibility. The examination is discipline-specific and is comprised of 5, 6 and 13 examination modules for RT, NM and RTT, respectively. Upon successful completion of the certification requirements, the students receive the appropriate discipline-specific professional designation in RT, NM, or RTT.

Admission Criteria

The minimum academic admission requirement was 1 yr of university education with an incoming GPA of B– (70–72%) and at least C– (60–62%) in each of the prerequisite courses in biology, mathematics, and physics (and chemistry for the NM discipline only). Applicants to the program also participated in a standardized interview. They were rated in four areas: communication, compatibility, initiative, and self-evaluation. Rating scores from each area of the interview were combined to give the final interview score, which was used as part of the admission criteria.

Success Criteria

In this study, the success criteria included exit GPA, performance on didactic courses, and the scores of each module on the national certification examination. GPA was calculated by dividing the total grade point value earned in each course by the total credit hours taken. The GPA ranges from 0.0 to 4.0. Grades were available for 19 courses for students in RT, 17 courses for students in NM, and 19 courses for RTT on a 100-point scale. An expert panel of senior administration for the program was convened to classify all numerically scored courses into categories to aid analysis. Consensus was reached on two distinct groups: technical knowledge and skills courses (TKS) and professional practice and patient care courses (PPP). Global scores for TKS and PPP were computed by averaging a student’s grades across each type of course. The 3 clinical courses were evaluated as pass/fail, with all students eventually passing, and these results did not contribute to the overall calculation of the GPA.

Statistical analyses were performed using SPSS 14.0 (SPSS, Inc., Chicago, IL). Descriptive statistics (mean and SD) were computed for all variables by discipline. Correlations among the variables within a discipline were also computed. An α value of 0.05 was used to determine significance.

The national certifying body agreed to disclose numeric grades of each examination module to the investigators with the consent of the student. A letter and consent form requesting permission to retrieve students’ national certification examination scores was sent to each student shortly before graduation. The consent forms were returned to a third party to ensure that students did not feel coerced into participating in the study. An estimated composite score was computed for each student as a weighted sum of the module scores, where the module weights were based on the proportion of the test items that contributed to each module score. The relationship among these scores was examined using correlations. A regression analysis was not performed because of the small sample sizes and the large proportions of students for whom certification examination scores were not available. The GPAs and demographics of those who consented to the release of their scores and those who did not consent were compared using t-tests and χ²-squared tests.

The ethics review boards of the educational institutions involved approved the study’s protocol.

Results

Admission and program success data were available for all 122 of the students who entered in September 2002: 31 RT, 27 NM, and 64 RTT students. Forty-six of the students consented to the release of their scores on the national certification examination: 15/31 (48.4%) RT, 8/27 (29.6%) NM, and 23/64 (35.9%) RTT students.

Table 1 summarizes by discipline the means and SDs of admission criteria scores, the exit GPA, and composite certification examination scores for those students who consented to the release of their results.

Table 2 presents the correlations among the admission criteria (undergraduate science course grades, undergraduate GPA, and interview score), program performance (program GPA, scores based on course performance), and certification examination performance (composite score) for the RT and RTT disciplines only. NM is not included in these analyses because only eight NM students consented to the release of their certification examination scores.

Admission Criteria and In-Program Success for RT and RTT Students

For the RT students, undergraduate grades in mathematics ($r = 0.580, p < 0.01$) and overall undergraduate GPA ($r = 0.435, p < 0.05$) were significantly correlated with performance on TKS courses. In contrast, performance on courses related to PPP was significantly correlated only with undergraduate grades in biology ($r = 0.475, p < 0.05$). Overall program GPA was significantly correlated only with undergraduate grades in mathematics ($r = 0.523, p < 0.05$).

For the RTT students, undergraduate biology ($r = 0.423, p < 0.01$), undergraduate physics ($r = 0.344, p < 0.01$), and overall undergraduate GPA ($r = 0.578, p < 0.01$) were significantly correlated with performance in courses related to TKS. Performance in courses related to PPP was also significantly correlated with undergraduate biology grades ($r =
There were no significant correlations noted between either discipline’s interview scores and any in-program performance metric.

**ADMISSION CRITERIA, IN-PROGRAM SUCCESS AND CERTIFICATION EXAMINATION RESULTS**

RT discipline performance on the certification examination was significantly correlated with undergraduate grades in mathematics ($r = 0.842, p < 0.05$) and with undergraduate GPA ($r = 0.561, p < 0.05$). RTT discipline performance on the certification examination was significantly correlated with undergraduate biology ($r = 0.432, p < 0.05$), undergraduate GPA ($r = 0.567, p < 0.01$), performance in TKS courses ($r = 0.567, p < 0.01$), performance in PPP courses ($r = 0.464, p < 0.05$), and overall program GPA ($r = 0.554, p < 0.01$).

Given the relatively small sample size, it is important to consider whether these students were representative of all the students within that discipline. Differences between consenting and nonconsenting students were analyzed by discipline and not found to be statistically different with respect to overall exit GPA for RT. However, RTT students who consented did have higher GPAs (mean 3.36 vs. 3.11), and the difference is statistically significant ($t(62) = -2.44, p = 0.02, d = -0.64$). When analyzed with respect to language of instruction of prior education (as determined by the inclusion of a language competency test score among the admission criteria), only the RT discipline could be evaluated. A statistically significantly greater number of consenting RT students were international students: 7/9 (77.8%) vs Canadian students 8/18 (36.4%) ($\chi^2(1) = 4.38, p = 0.04$). No differences in years of undergraduate education prior to admission were noted between the consenting and nonconsenting students in either discipline.

**Discussion**

This study explored the relationship between traditional admission criteria and program success in a cohort of 122 students in a newly established medical radiation sciences program. While all students eventually completed the program, thus limiting the loss of data from attrition (as seen with other studies of this nature), we cannot comment on how students who did not meet admissions criteria would have performed were they selected. However, we were able to obtain sufficient postgraduation data for two subsets of students and to correlate admission criteria and in-program performance metrics with postgraduation performance on a national certification examination. Correlating admission criteria with postgraduation performance is rarely reported due to difficulties in obtaining the necessary data.

This study produced a number of expected results, including the positive correlation between preadmission overall GPA, performance in biology, mathematics, and physics, and in-program performance on both the TKS and PPP courses, as well as exit GPA. This underscores the importance of science prerequisites in a medical radiation sciences program.

While there were similarities noted between the RT and RTT disciplines, there were some differences. For example, in both disciplines, undergraduate grades in biology were significantly correlated with good performance in PPP courses, and preadmission GPA was significantly correlated...
with performance in the discipline-specific technical courses. However, in the RT discipline, it was mathematics, not biology and physics as in the RTT discipline, which was significantly correlated with success of TKS courses.

The small sample sizes within each discipline limited the power of the statistical tests of relationships among the admission criteria, the measures of program performance, and the performance on the certification examination. It is also important to note that the RTT discipline has more students, so that although many of the correlations are of a similar size as those for RT, they were more likely to be statistically significant.

However, it does appear that the correlation of the certification examination composite score with the admission criteria and measures of program performance differed by discipline. For RT students, the strongest correlation was with undergraduate marks in mathematics. This could be attributed to certain approaches in radiological methodology. One of the smallest correlations is with grades in the courses related to PPP. This pattern is not surprising, as more than half (55%) of the certification examination score in RT is based on imaging procedures. Only 28% of the examination is based on questions related to patient care and professional practice. For RTT students the pattern is different. The certification examination was not strongly correlated with undergraduate marks in mathematics. However, there were strong correlations with both TKS and PPP courses and the certification examination score. This is not surprising, as almost half (47%) of the score was based on questions about interactions with patients or other staff or ensuring their safety. It is worth noting that the RTT students who consented to release of their certification examination scores did have a statistically significantly higher exit GPA than the nonconsenting students, which may have positively biased this result.

It was disappointing that there were no observed positive correlations between the noncognitive component of the admissions criteria and any in-program or certification examination outcomes. This could in part be attributed to the exclusion of performance on clinical courses, as they were graded pass or fail. In examining the 122 records further, only six students performed poorly in the clinical courses and required a change in their academic status to remediation or remediation with probation, and four of these required a program extension. An examination of the data does not reveal clear patterns. While these six students had final GPAs of <2.7, this was not statistically significantly different from the overall group. Compared with students who did not encounter academic difficulty, the RT students entered the program with lower undergraduate mathematics grades but higher interview scores, while the RTT students entered with higher mathematics grades and lower interview scores. However, because of the small number of students encountering academic difficulties in each discipline, it is not possible to determine whether these differences are significant. Of interest

<table>
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<th>TABLE 2. Correlations for RT and RTT Disciplines</th>
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<td><strong>Estimated Composite Score</strong></td>
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<td><strong>GPA</strong></td>
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<td><strong>Note:</strong> Correlations in the upper right half of the table are for students in RT discipline (n ranges from 7 to 31 because of incomplete data); those in the lower left half are for students in RTT discipline (n ranges from 18 to 64). p &lt; 0.05; † p &lt; 0.01.</td>
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though, all six students performed particularly poorly in a technical course Comparative Imaging Modalities, with an average grade of 62.7 compared to an average of 75.5 for the other students; this difference was statistically significant ($t(11.2) = 13.06$, $p < 0.001$, $d = 5.47$). However, because of the small number of students encountering academic difficulties in each discipline, it is not possible to determine whether these differences are worthy of further investigation.

**Conclusion**

As stated at the outset, the predictive validity of admission criteria, determined using numerous sources of preadmission educational information and professional judgment, can only be verified by tracking a student’s success in the program and on the subsequent certification examination. This study has shown that the current admission criteria are doing a reasonable job of predicting student success in the didactic components of the University of Toronto/Michael Medical Radiation Sciences program and the certification examination. The added value of an interview in assessing students’ success in the noncognitive domains, either in program or subsequent examination, could not be validated. Nevertheless, clinical practical courses constitute 30% of the program curriculum. The relationship of the admission criteria with student success could be better determined if the clinical practical courses were graded numerically, providing finer gradations of performance.

New interview tools, such as multiple mini-interviews, which is used in medical school interviews and medical specialty training programs, may be considered in order to provide additional insight into the noncognitive behaviour of the applicants.\(^{23,24}\)

**References**

22. Committee on Education, Canadian Association of Medical Radiation Technologists: Competency Profile, Radiological Technology, Nuclear Medicine, Radiation Therapy. Ottawa, CAMRT, Jan 2002.