October 2017

The Predictive Value of Subjective and Objective Application Variables an The Global Rating of Applicants to a General Surgery Residency Program

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Abstract

Purpose

One of the most critical aspects of a residency program is the recruitment and selection of candidates that will be the best fit for the program and will enhance the future growth and development of the program. The purpose of this study is to determine if the objective and subjective aspects of a candidate's application have significant impact on the candidate's overall global rating scale (GRS) which is a scoring system utilized by our program to rate individual candidates based on their overall application.

Methods

This is a retrospective cohort study looking at the ERAS applications of 438 candidates to a medium sized rural general surgery program. The GRS is a scale from 1 to 10 which is a composite score of multiple variables which are rated by a group of 10-18 faculty reviewers.

Results

It was noted that having been previously accepted to another residency training program had a deleterious effect on the candidate's GRS while Alpha Omega Alpha (AOA) membership, honors in a clinical rotation, USMLE Step II Score, letters of recommendation, personal statement, and volunteer work were all found to statistically affect the GRS.

Conclusions

It was found that both objective and subjective factors had a statistically significant affect on a candidate's GRS. Interestingly, the difference between USMLE Step I and Step II scores, which was found to be significant in our original study, was no longer found to be significant in this study. The single most significant factor of a candidates overall GRS was the failure of a basic science course.

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Section 1: Introduction

One of the most critical aspects of a residency program is its recruitment. Every year program leaderships spend countless hours reviewing hundreds of applications and comparing candidates in an effort to recruit those applicants that will be the best fit for the program and will enhance the future growth of the program.[1-5] Residency applications submitted through the Electronic Residency Application Service (ERAS) are complex files consisting of both statistical measures of the candidate's previous academic performance as well as subjective measures of their character and clinical skills. At this time, there is no consensus on what qualitative and quantitative aspects of an applicant's ERAS file are most indicative of future success of the candidate. Some previous studies such as the one conducted by Stohl et al indicate that subjective data within letters of recommendation (LORs) are the best predictors of success.[6] Other studies such as the one conducted by Shellito et al. suggest that qualitative measures of a candidate's ERAS file are more predictive of future success.[7] It would be ideal to be able to look at a candidate's application and to be able to condense the complicated subjective and objective materials contained in the application into a universal scale to allow for direct comparison of applicants.

Given the importance of candidate selection to the future of a residency program, there have been several studies looking at objective qualities of a candidate's application and correlation to successful completion of residency in good standing. Most of these studies focus on USMLE scores, medical school performance based on grade performance and class rank, and Alpha Omega Alpha (AOA) distinction.[2-7] Other studies have looked at subjective factors and mostly focus on the personal statement (PS) written by the candidate and at the LORs written typically by attending physicians on behalf of the candidate.[7-9] One challenge of subjective studies is that despite PSs, LORs being standard inclusions in the application, most residency programs do not require a standardization of the information provided within these documents, and this makes comparison of applications challenging. Reviewer inter rater reliability and comparison of more than one residency program's evaluation methods of these subjective application materials pose a great challenge to researchers.[10] There continues to be controversy as to if these subjective factors even influence the residency selection committee's decision-making process.[4, 9] Some studies, particularly one conducted by Stain et al., suggest that a candidates PS has no correlation to their future success as a resident.[4]

Prior to our previous study on this topic, most research had focused on either subjective or objective application factors.[14] In our previous study, we looked at the development of a global rating scale (GRS) for applicants to a medium sized rural surgical program that included both objective and subjective parts of the candidate's ERAS application. We previously found that having no prior residency training, higher USMLE Step II scores, previous medical work experience, higher reviewer rating of the PS and having LORs from surgeons in leadership positions all were statistically significant factors in a higher GRS. Based on our previous work we have continued to modify our GRS to develop a tool that can be applied to all applications and focuses on those factors of the candidate's application that are significantly linked to a candidate being ranked highly by residency program within The Match. The purpose of this study is to look at our revised GRS and determine which of the objective and subjective aspects of a candidate's application have significant impact on the candidate's overall GRS.

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Section 2: Materials and Methods

The design of this study is a retrospective cohort study looking at the ERAS applications of 438 applicants to a medium sized rural general surgery program. Our program offers 4 categorical surgical positions per year. Applications were reviewed from the years of 2011 to 2017 covering applicants over 7 admission cycles. To be included in the study, applicants had to complete an interview and receive a GRS from the admissions committee.

The GRS is a scale from 1 to 10 which is a composite score from 10-18 faculty reviewers who have been trained on the GRS. All scores are averaged to give the candidate their final GRS (Figure 1). Since the time of our last study, implementation of blinded interviews have been instituted. Those faculty that are blinded are only given the candidates name prior to interviewing the candidate and do not see the other materials contained in the ERAS application until completing the interview.

OVERALL SCORE: (Please circle)

Rank, Actively Recruit			Rank, Will be good resident			Rank, Adequate			Do Not Rank
10	9	8	7	6	5	4	3	2	1

FIGURE 1. Global rating score. A 10-point scale used by faculty interviewers to rate an applicant based on their application and interview. A total of 4 anchors were used to assist the raters in standardizing their scores.

Variables were classified as objective if no rating of the variable was required. Objective variables included prior residency training, AOA distinction, failure of a basic science, prior rotation with our department, clerkship honors distinction, surgery clerkship grade, other advanced degree or graduate school training, geographical connection to the region, medical school class rank, USMLE step I score, USMLE Step II score, and the USMLE delta or difference between the step I and step II scores. Subjective variable were classified as those requiring a rating. These included the mean score of the LORs, the mean score of the PS, prior volunteer work, and prior research experience. Higher exam scores, AOA membership and clerkship distinction would portend to a higher applicant rating, while failure of a basic science course would lead to a less favorable applicant rating.

2.1: Letters of Recommendation

A quantitative method of assessing LORs was devised. Stohl et al. have previously utilized the Accreditation Council for Graduate Medical Education Core Competencies to evaluate the quality of LORs.[6] By evaluating the 6 core competencies - Patient Care, Medical Knowledge, Practice-Based Learning, Interpersonal and Communication Skills, Professionalism, and Systems-Based Practice – they found statistically significant correlation between the candidates that they ranked in the top quartile and references to at least one of the six core competencies in the applicant's LORs. Based on the research by Stohl et al. we determined that LORs should address patient care, medical knowledge, professionalism, and interpersonal and communication skills.[6] We have developed a rating method on a scale of 1 to 10 for LORs in our study, which include these core competencies as well as several other factors focused on integrity and surgical interest (Figure 2).

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FIGURE 2. Letters of recommendation rating scale. A 10-point scale used by raters evaluating letters of recommendation. The rating was determined by how many of the 5 factors were mentioned in the letter.

Letter of Recommendation Evaluation Sheet

1)	**Length of Time known applicant**	**1 year or more**	**<1 year**				**Value**
		1	0				
2)	**Contact with applicant**	**Extended direct clinical or research contact (>10 hrs)**	**Limited direct clinical or research contact (<10 hrs)**	**1-3 times to discuss application**	**Indirectly through others/ evaluation**		
		3	2	1	0		
		Very Positive Comments (Exceptional)	**Positive Comments (Above Average)**	**Neutral Comments; Not Mentioned (Average)**	**Negative Comments (Below Average)**		
3)	**Patient Care**	3	2	1	0		
4)	**Medical Knowledge**	3	2	1	0		
5)	**Professionalism**	3	2	1	0		
6)	**Interpersonal and Communication Skills**	3	2	1	0		
7)	**Procedural Skills**	3	2	1	0		
8)	**Research**	3	2	1	0		
9)	**Initiative and Drive**	3	2	1	0		
10)	**Commitment to Gen Surg**	3	2	1	0		
11)	**Commitment to Academic Med**	3	2	1	0		
12)	**Match Potential**	3	2	1	0		
13)	**Unique Features**	3	2	1	0		
14)	**Overall Feel of Letter**	5	4	3	2	1	
	TOTAL	42				**Total**	0
						Out of 10	0
						Writer Title	
						Final Score	0

Possible Titles:	*Surgeon Leader*	*Surgeon Non- Leader*	*Other*
Examples:	Department Chief; Department Chair; Program Director; Clerkship Leader	Associate Program Director; Surgeon	Physician (other than surgeon); Non-Physician; Other
Letter Coefficient:	1	0.9	0.8

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Two LORs were selected for each applicant seeing as this is the minimum number of letters that can be submitted. For those with more than two LORs, letters were favored from those authors who were in leadership positions. Once two LORs were selected for each applicant, the letters were deidentified and given to two raters for evaluation. Raters were given some latitude in scoring based on how enthusiastic the author was in their evaluation. The two rater's scores were then averaged together to make a composite LOR score.

2.2: PS Evaluation

A quantitative method for evaluating PSs was also created. In a study by Max et al, they identified the most frequently found themes and content of the PS.[8] They also looked at the responses of 70 program directors identifying what program directors felt was the most important features of the PS. The vast majority of program directors (95%) cited the ability to convey strong written expression was "very important". Other notable factors included 35% of program directors rating originality and 25% rating reasons for selecting their specialty as "very important".

Based off of the study by Max et al.,[8] a 3-part scoring system for the PS was developed (Figure 3). The three parts are originality, passion, and written expression and ware each rated on a 10 point scale. Each PS was deidentified and scored by two evaluators. The average score of both raters was then calculated to determine the overall score.

	10	9	8	7	6	5	4	3	2	1
Originality	- **Distinct, original** - **Memorable, believable personal narrative** - **Highly compelling**					- **Typical, unoriginal** - **Lacks personal narrative or seems exaggerated** - **Uninspiring or off-putting**				
Passion	- **Unquestionably passionate for surgery** - **Unquestionably passionate for patient care** - **Unique explanation for these interests**					- **Little to no expressed passion for surgery** - **Little to no interest for patient care** - **Dubious explanation for applying to residency**				
Written Expression	- **Clear grasp of grammar and sentence structure** - **Appropriate and compelling word usage** - **Clear content organization**					- **Poor grammatical and sentence structure** - **Inappropriate or mediocre word usage** - **Vague content organization**				

FIGURE 3. Personal statement rating scale. A 10-point scale used by raters evaluating personal statements. The statements were rated separately for originality, passion for surgery, and written expression using the anchors shown. The average personal statement score as well as the individual scores for the 3 components was used in the analysis.

2.3: Volunteer Work

Assessment of volunteer work was based on commitment, quality and altruistic significance. Volunteer work was assessed in a deidentified fashion and individually rated by three reviewers on a scale of 1 to 10 and these scores were then averaged for a composite score.

2.4: Statistical Analysis

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Analysis was preformed using SAS statistical software, version 9.4 (SAS Institute Inc. Cary, NC). Categorical data was expressed in frequency (percentage) and continuous data was expressed as mean +/- standard deviation or Pearson's r. Two sample t-tests were then implemented to look for the effect of categorical data on the overall GRS. A simple linear regression was applied to continuous data to look for effect of continuous data on the overall GRS. A multivariate stepwise linear regression was applied to determine the significant variables that influence the overall GRS. Significance was defined as $p < 0.05$. Institutional review board approval was not required for this study.

Section 3: Results

A total of 438 applicants from 2011 to 2017 were included in the study. Table 1 shows the variables examined and the average overall GRS based on those variables. Several themes present in the original version of this study continue to be present. Having been involved in a prior residency program once again had an overall deleterious effect on GRS and proved to be significant ($p=0.0001$). The presence of AOA was once again a significant variable and carried with it the highest overall average GRS of 7.9 ($p=0.003$). However, it accounted for a low percentage of total applicants (3.7%). Several new variables were introduced to the grading system and were shown to be significant. Having received honors in a rotation, especially if it was a surgical rotation, resulted in an overall higher GRS. When specifically evaluating surgical clerkships, applicants receiving honors in the rotation received an overall higher GRS ($p<0.0001$) and represented 39.3% of all applicants. Having a graduate student degree did not have a statistically significant effect on GRS. Table 2 shows additional variables and their subsequent linear relationship as either showing a positive or negative association with an effect on GRS. Performance on USMLE Step I and II was another objective criterion that was examined. While found to be significant on the univariate analysis, Step I did not have a significant effect on GRS and was shown to not be significant on multivariate analysis (Figure 4). Figure 5 shows USMLE Step II was found to be statistically significant in relation to the GRS ($p<0.0001$). A variable called USMLE delta was created to analyze the difference between Step I and II scores and to test the effect of an improved USMLE score in the minds of the rater. While this was found to be of particular interest and significance in our previous study, it was not found to be statistically significant for this study ($p=0.158$). Figure 6 shows this relationship.

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Table 1 - Univariate Analysis of the Effect of Objective Factors on Global Rating Score

Variable	n	%	GRS	p value
Prior Residency				0.0001
No	372	84.9%	7.1 ± 1.2	
Yes	66	15.1%	6.5 ± 1.4	
AOA				0.003
No	422	96.3%	7.0 ± 1.2	
Yes	16	3.7%	7.9 ± 1.0	
Basic Science Failure				<.0001
No	407	92.9%	7.1 ± 1.2	
Yes	28	6.4%	6.0 ± 1.5	
Missing	3	0.7%		
Junior Clinical Clerkship Honors				<.0001
None - 0	168	38.4%	6.8 ± 1.1	
Psych - 1	17	3.9%	7.1 ± 0.7	
OBGY or Peds - 3	38	8.7%	6.6 ± 1.3	
Medicine - 4	38	8.7%	6.9 ± 1.6	
Surgery - 5	171	39.0%	7.4 ± 1.2	
Unknown	6	1.4%		
Surgery Clerkship Grades				<.0001
Fail/Incomplete	7	1.6%	7.1 ± 1.1	
Pass (C)	108	24.7%	6.8 ± 1.2	
High Pass (B)	145	33.1%	6.8 ± 1.2	
Honors (A)	172	39.3%	7.4 ± 1.2	
Unknown	6	1.4%		
Previous Rotation				0.060
No	411	93.8%	7.0 ± 1.2	
Yes	27	6.2%	7.5 ± 1.9	
Connection with Region				0.035
No	320	73.1%	6.9 ± 1.2	
Yes	118	26.9%	7.2 ± 1.3	
Grad School Degrees				0.148
No	366	83.6%	7.0 ± 1.3	
Yes	72	16.4%	7.2 ± 1.2	

Note: All p values calculated with known data

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Table 2: Relationship of objective and subjective components of the ERAS application having a linear relationship on the GRS

Variable	n	r	p value
Medical School Rank	438	-0.116	0.016
USMLE I	436	0.120	0.012
USMLE II	418	0.197	<.0001
USMLE CHANGE	418	0.069	0.158
LOR mean score	438	0.140	0.003
Personal Statement mean score	437	0.182	0.000
Volunteer work score	438	0.155	0.001
Research	438	0.095	0.047

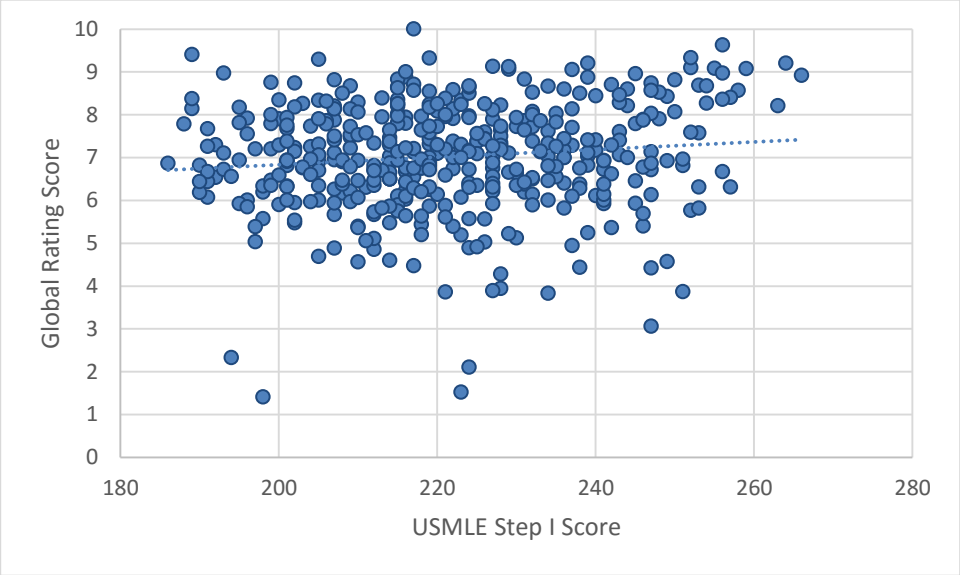

FIGURE 4. Bivariate analysis of the effect of USMLE Step I score on the global rating score.

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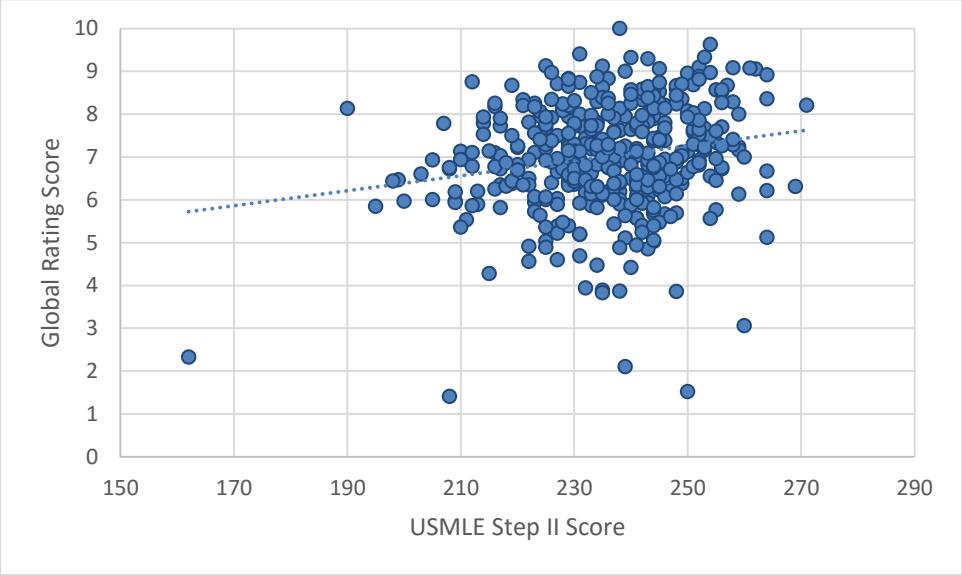

FIGURE 5. Bivariate analysis of the effect of USMLE Step II score on the global rating score.

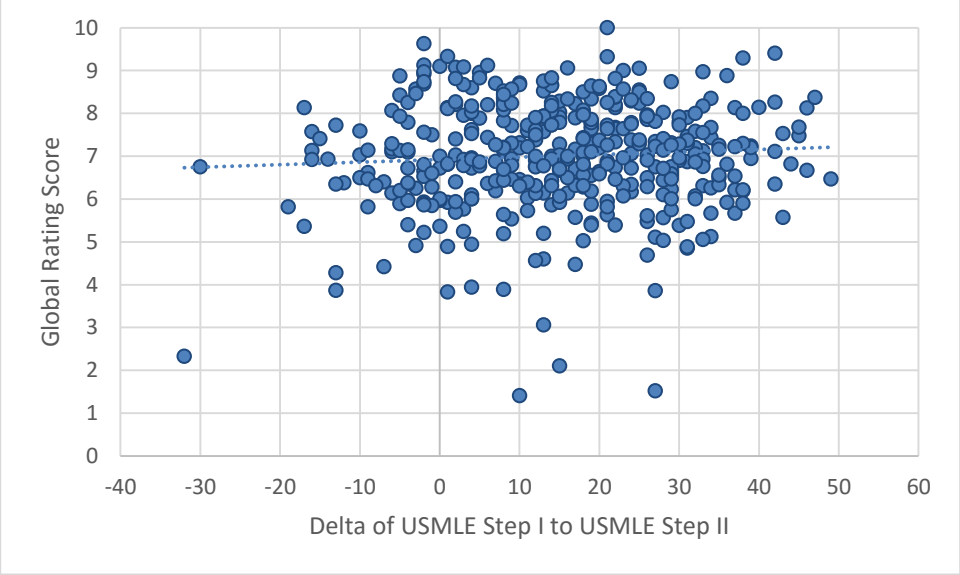

FIGURE 6. Bivariate analysis of delta of USMLE Step I to USMLE Step II on the global rating score.

Subjective factors include average LOR score, PS score and volunteer work score and were all found to be statistically significant on univariate and multivariate analysis in relation to GRS.

Finally, multivariate stepwise regression was performed on all variables determined to be statistically significant to determine which variables had the greatest effect on GRS (Table 3). Results revealed that USMLE Step II score,

personal statement mean score, volunteer experience, prior residency, AOA membership, basic science failure, having previously rotated as a medical student on our general surgery services and surgery clerkship grades as all being statistically significant. From the parameter estimates, we were able to approximate which variables carry the most weight. Of the previously mentioned variables, basic science failure and having been in a previous residency were all found to have a negative effect on GRS.

Table 3. Multivariate Stepwise Linear Regression.

Variable	Parameter Estimate	Standard Error	Standardized Estimate	p value
Intercept	2.742	1.050	0.000	0.009
USMLE Step II Score	0.010	0.004	0.117	0.014
Personal Statement Mean Score	0.141	0.057	0.114	0.014
Volunteer Experience	0.096	0.030	0.147	0.001
Prior Residency	-0.675	0.165	-0.198	<.0001
AOA Membership	0.649	0.310	0.096	0.037
Basic Science Failure	-0.923	0.225	-0.186	<.0001
Previous Rotation	0.704	0.265	0.126	0.008
Surgery Clerkship Grades	0.178	0.068	0.122	0.009

Section 4: Discussion

As in the earlier version of this study, our investigation was performed with the goal of providing empirical insight into the admissions process in a general surgery residency program. Additional intentions are applying the conclusions to other training programs, both in general surgery and other specialties. The residency application consists of a multitude of subjective and objective criteria. Subjective variables were specifically those that required rater evaluation and included PS, LOR and volunteer work. Several studies have questioned the utility of such variables.[4, 9, 10] Additionally, a high level of interrater variability was thought to take away from the effect of these factors. This is a particularly interesting trend as one study that surveyed medical students found that they typically overrate the importance of subjective variables and underrate objective factors.[11]

The results of this ongoing research clearly corroborate the findings of several other studies as related to objective factors in resident selection.[2-6, 12, 13] In our current study, USMLE Step II scores had a significant effect on GRS while USMLE Step I scores, once again, were not significant. Only 2 of the 7 studies reference previously showed USMLE Step II scores to be of higher significance than Step I. Interestingly, while the delta in our original study proved to be significant, it was no longer significant in our current study. It was noted that both USMLE Step I and II scores have been increasing over the past several interview seasons. An attempt was made to adjust for the interview season, however, the delta still remained insignificant. It can be hypothesized that as time progressed,

raters seemed to place less emphasis on improvement from USMLE Step 1 score.

In the previous version of this study, the number of applicant publications was analyzed. In contrast to published data, it was found that this was not a significant variable in determining the GRS and thus was not included in the GRS for the 2013-2016 applications. However while the number of publications was not found to be significant, the presence of some sort of research was still viewed favorably and found to be significant. Having been in a prior residency continued to have a significant and negative effect on the GRS. The addition of "failure of basic science" as a variable was included in the 2013-2016 data. It was shown to have the single largest negative effect on the GRS. This makes intuitive sense as the medical field in general is dominated by basic science principles and mastery of such knowledge is essential to any applicant.

Interestingly, in our previous study, the applicant's personal statement and LOR were found to have a significant effect on the GRS in our multivariate analysis. In contrast, this was not apparent in our current study. While the weight of each variable remained the same in the overall GRS, their significance was no longer apparent. The additional power added to the study certainly may have played a roll in showing their insignificance.

This study is not without its limitations. While the total number of applicants in the applicant pool increased from 188 in our previous study to 438, it is still based on a single institution study.[14] Undoubtedly, the cooperation and collaboration amongst other residency programs would add significant power to the study providing similar evaluation methods. The evaluation of subjective criteria is an obvious limitation to the study. Such variables continue to be difficult to entirely quantify and would undoubtedly benefit from an increase in the number of evaluators thus increasing interrater reliability and accuracy. Finally, as in our previous version of this study, the effect of the interview itself was not included in the admission process as it was entirely incorporated into the applicant GRS.

In conclusion and as in the previous version of this study, its significance lies in identifying factors that significantly affected the selection of applicants in a general surgery residency program. The increase in USMLE step II scores, prior residency, failure of basic science courses and having a previous rotation with residency program as a student all had significant effects on the applicants overall rating. While the large increase in the number of applicants did add additional depth to the study, it did not fundamentally change the results and further enforced the importance grader place on certain variables. The findings may provide a basis for future investigations and may additionally be of benefit in improving selection efficiency and structure.

Section 5: Conclusions

It was found that both objective and subjective factors had a statistically significant affect on a candidate's GRS. Interestingly, the difference between USMLE Step I and Step II scores, which was found to be significant in our original study, was no longer found to be significant in this study. The single most significant factor of a candidates overall GRS was the failure of a basic science course.

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