Critical Comparison of the Quality and Content of Integrated Vascular Surgery, Thoracic Surgery and Interventional Radiology Residency Training Program Websites

Katherine J. Jensen[3], Qi Yan[2] and Mark G. Davies[1,4]*

1 Division of Vascular and Endovascular Surgery,University of Texas Health at San Antonio, Texas, US

2 Department of Surgery,University of Texas Health at San Antonio, Texas, US

3 Long School of Medicine,University of Texas Health at San Antonio, Texas, US

4 South Texas Center for Vascular Care, South Texas Medical Center, Texas, US

*Corresponding authors:
Mark G. Davies

✉ daviesm@uthscsa.edu

Tel: +7138284569

Division of Vascular and Endovascular Surgery, University of Texas Health at San Antonio, Texas, US

Abstract

Objective: With the move to virtual interviewing, residency websites are an important recruitment resource, introducing applicants to programs across the country and allowing for comparison. Recruitment is highly competitive from a common potential pool between vascular surgery, thoracic surgery and interventional radiology with the ratio of applicants to positions being highest in interventional radiology, followed by thoracic surgery and lastly vascular surgery, as reported by the National Resident Matching Program. The aim of this study is to evaluate the accessibility and availability of online content for those integrated residency programs.

Methods: A list of accredited vascular surgery, thoracic surgery, and interventional radiology residencies was obtained from the ACGME. Program websites were evaluated by trained independent reviewers (n=2) for content items pertaining to program recruitment and education (scored absent or present). Statistical analysis was performed in R software.

Results: Of ACGME accredited programs, 56 of 61 (92%) vascular surgery, 27 of 27 (100%) thoracic surgery, and 74 of 85 (87%) interventional radiology programs had functional websites (P=0.122). Vascular surgery websites contained a median of 26 content items (IQR: 20, 32), thoracic surgery websites contained a median of 27 content items (IQR: 21, 32), and interventional radiology websites contained a median of 23 content items (IQR: 18, 27). Two content items considered highly influential to applicant program decision are procedural experience and faculty mentorship, were reported at 32% and 11% for vascular surgery, 19% and 11% for thoracic surgery, and 50% and 15% for interventional radiology (P=0.008 and P=0.751, respectively). Key deficits were work hours, debt management and curriculum for interventional radiology; resident profiles, sample contracts, and research interests in vascular surgery; operative experiences, program director contact and message for thoracic surgery. Interventional radiology deficits were work hours and thoracic surgery deficits were procedural experience. Both IR and CT websites lacked information in evaluation criteria and faculty mentorship.

Conclusions: This study has uncovered key differences in availability of online content for residencies recruiting from the same pool of applicants. Thoracic surgery has the most information, followed by vascular surgery, with interventional radiology reporting the least content. In the era of virtual interviewing from the same potential pool of applicants, programs should review and revise their web presence with the aim to increase the availability of online content in order to attract valuable candidates.

Keywords: Training; Recruitment; Integrated residency; Website; Content; Quality; Vascular surgery; Thoracic surgery; Interventional radiology

Introduction

The role of vascular surgeons in the medical environment has changed considerably with the increasing use of endovascular approaches for treatment of vascular lesions [1]. By 2026, it is predicted that 75% to 95% of overall vascular lesions (aneurysms, stenosis, occlusive disease, traumatic vascular lesions, etc.) will be treated endovascularly [1,2]. Vascular surgery, as always, will continue to compete in recruitment with cardiac surgery for procedural domain but, with the increasing use of endovascular approaches, it faces additional recruitment competition from interventional radiology [2]. Due to the overlap in patient populations, professional interests, skills, and treatments performed by vascular surgeons, thoracic surgeons, and interventional radiologists, these specialties appeal to a common potential applicant pool and recruitment is highly competitive among these training programs.

Candidates for residency programs increasingly use the Internet to research potential programs for application [3-5]. Online information has been analyzed for a range of residency and fellowship programs, including orthopedic surgery, plastic and reconstructive surgery, emergency medicine, cardiothoracic surgery, neurosurgery, otolaryngology, trauma surgery, surgical critical care, acute care surgery, microsurgery, interventional radiology, and vascular surgery [3,5-21]. Studies have individually analyzed the availability of online content for integrated vascular surgery, [21] thoracic surgery, [8] and interventional radiology [11,19] training program websites but, to our knowledge, no study has compared the accessibility and availability of online content across these training programs. Given the importance of online resources in recruiting prospective applicants and the current mandates to move to virtual interviewing, we sought to assess the current state of integrated vascular surgery, thoracic surgery, and interventional radiology training program websites. The purpose of this study is to evaluate the presence, accessibility, and comprehensiveness of integrated vascular surgery, thoracic surgery, and interventional radiology training program websites.

Methods

Study design: A comprehensive list of accredited integrated vascular surgery, thoracic surgery, and interventional radiology residencies was obtained from the Accreditation Council for Graduate Medical Education (ACGME) database. Programs participating in the 2020 National Resident Matching Program were eligible for study inclusion. Following identification of all programs with websites, programs were accessed and evaluated by two independent reviewers (one medical student and one resident) for availability of recruitment and educational content items. The websites were viewed independently by each reviewer. Program search and review was performed in November 2019.

Research Question: Are there key differences in the three specialty program websites for integrated residencies that could potentially impair recruitment efforts in the virtual environment?

Accessibility of websites: Accessibility of websites was determined by surveying Accreditation Council for Graduate Medical Education (ACGME) database for the total number of programs listed and the presence or absence of website links. Links, if they were provided, were characterized as either functional or nonfunctional. Functional links led to a website. Nonfunctional links led to an error page. Functional links were then evaluated as being either 'direct' (landing directly on the program webpage) or 'indirect' (landing on a different page, such as the departmental website, requiring further action by the reviewer to access the specific program webpage if possible).

Availability of content: Websites for integrated vascular surgery, thoracic surgery, and interventional radiology residency programs were analyzed for availability of information used to inform and recruit prospective applicants. Content items on recruitment and education listed in (**Table 1**) were selected based on ACGME program requirements as well as previously published literature reviewing online content of residency and fellowship programs [5,10,14,15] Content on the training program websites was counted as present if (1) it was present on the main training program webpage or (2) it was accessible via a direct link provided on the main training program webpage.

Program recruitment and education: Websites were evaluated for content relevant to program recruitment and education. Program recruitment information included faculty listings, faculty and departmental research interests, alumni career placements and information on current residents. Recruitment information regarding the application and interview process as well as general resident quality of life metrics were also evaluated see (**Table 1)**. Program education content addressed operative and didactic training. It also covered resident research opportunities. Overall, 41 program recruitment and 16 program education content items were evaluated.

Rater training and consistency: Each website was accessed and evaluated by two reviewers (one medical student and one resident) for availability of content items as well as quality of websites (determined as a function of four dimensions: content, design, organization, and user friendliness, see **Figure 1** for evaluation criteria). Each reviewer was trained by examining an optimal website, an average website, and a below average website with the senior author. Disputed assessments were resolved by consensus following discussion with the senior author. Reviewers were not blinded. Overall, there was considerable inter-rater reliability with 81% agreement (kappa = 0.74).

Data analysis: Intergroup analysis of continuous variables was performed using ANOVA. Categorical variables were compared using Chi-squared analysis. Statistical significance was defined at p<0.05. Percent agreement and kappa statistics were calculated for inter-rater reliability. Statistical analysis was performed using statistical software R version 4.0.0 (2020-04-24, R Core Team, Vienna, Austria).

Results

Accessibility of websites: Of the programs included in this analysis, 53 of 61 (87%) vascular surgery, 24 of 27 (89%) thoracic surgery, and 81 of 85 (95%) interventional radiology programs provided a link to their program webpage on the ACGME webpage (P=0.182). Of those programs that provided links, 47 of

Table 1 Content features included in evaluation of integrated vascular surgery, integrated thoracic surgery, and integrated interventional radiology training program websites.

Program recruitment (n = 41)	Program education (n = 16)
Program description	Rotation schedule
Number incoming positions available	Didactic instruction
Faculty listing	Research requirements
Faculty education and training history	Research interests (department/faculty)
Faculty profile (descriptive)	Operative experience
Faculty publications	Journal club
Faculty contact information	Conference schedule
Current residents	National/regional meetings attended
Resident education history	Evaluation criteria
Resident profiles	Faculty mentorship
Resident contact information	National organization link
Alumni listing	Curriculum
Alumni education history	Company link
Alumni contact information	Elective rotation
Alumni career placement	Simulation training
Board examination performance Program chair message	Vascular lab
Program director message	
Program director contact	
Administrative/coordinator contact Facility description	
Application requirements	
Selection process	
Interview dates	
Interview day details	
ERAS link	
If present, is ERAS link functional?	
Call requirement Contract Salary	
Work hours Benefits	
Vacation	
City information	
Domestic considerations Wellbeing strategies	
Debt management	
Meal allowance Educational fund Parking VISA	
ERAS, Electronic Residency Application Service.	

53 (89%) vascular surgery, 21 of 24 (88%) thoracic surgery, and 74 of 81 (91%) interventional radiology programs were considered functional (P=0.244). Few links landed directly on the program webpage. Of the programs that provided functional links: 17 of 47 (36%) vascular surgery, 7 of 21 (33%) thoracic surgery, and 17 of 74 (23%) interventional radiology programs provided links that landed directly on the program webpage (P=0.521). Overall, 56 of 61 (92%) vascular surgery, 27 of 27 (100%) thoracic surgery programs, and 74 of 85 (87%) interventional radiology programs

had a dedicated webpage (**Table 2**).

Availability of content: Content was assessed in two domains: recruitment and education. Of the 57 recruitment and education content items included in this analysis, vascular surgery program webpages contained a median of 26 content items (IQR: 20, 32), thoracic surgery program webpages contained a median of 27 content items (IQR: 21, 32), and interventional radiology program webpages contained a median of 23 content items (IQR: 18, 27). Of the 41 recruitment content items included in this analysis, vascular surgery program webpages contained a median of 19.5 content items (IQR: 15, 24), thoracic surgery program webpages contained a median of 20 content items (IQR: 16, 24), and interventional radiology program webpages contained a median of 18 content items (IQR: 15, 21). Of the 16 education content items included in this analysis, vascular surgery program webpages contained a median of 7 content items (IQR: 4, 9), thoracic surgery program webpages contained a median of 6 content items (IQR: 4, 7), and interventional radiology program webpages contained a median of 4 content items (IQR: 3, 7). A detailed quantification of availability of content items can be seen in **Table 3**.

Vascular surgery: For program recruitment, almost all programs provided information on program description (100%), faculty listing (95%), faculty education (93%), administrator or coordinator contact information (95%), facility description (89%), descriptive faculty profiles (82%), and the number of incoming positions (79%). The majority of programs provided information on application requirements (75%), a link to ERAS (63%), ERAS link was functional (63%), benefits (70%), salary (61%), current residents (71%), city information (59%), resident education history (63%), domestic considerations (57%), vacation policy (57%), and interview dates (57%). Less than one-half of programs provided information on program director contact information (43%), faculty publications (43%), wellbeing strategies (46%), faculty contact information (30%), program director message (30%), alumni listing (36%), alumni career placement (27%), educational fund (34%), parking (30%), non-national visa information (39%), meal allowance (29%), call requirement (39%), alumni career placement (27%), and debt management (39%). Fewer than one-quarter of programs provided information on sample contracts (16%), resident profiles (18%), interview details (18%), work hours (21%), and alumni education history (13%). Almost no programs provided information on their selection process (7%), resident contact information (9%), program chair message (9%), board examination performance (7%), and alumni contact information (2%).

For program education, almost all programs provided information on rotation schedule (84%). The majority of programs provided information on didactic instruction (70%), research requirements (73%), journal club (61%), and vascular lab training (RPVI; 64%). Less than one-half of programs provided information on departmental research interests (39%), operative experience (32%), meetings attended (46%), elective rotations (45%), conference schedule (38%), curriculum (38%), and simulation training (34%). Fewer than one-quarter of programs provided information on evaluation criteria (16%) and faculty mentorship
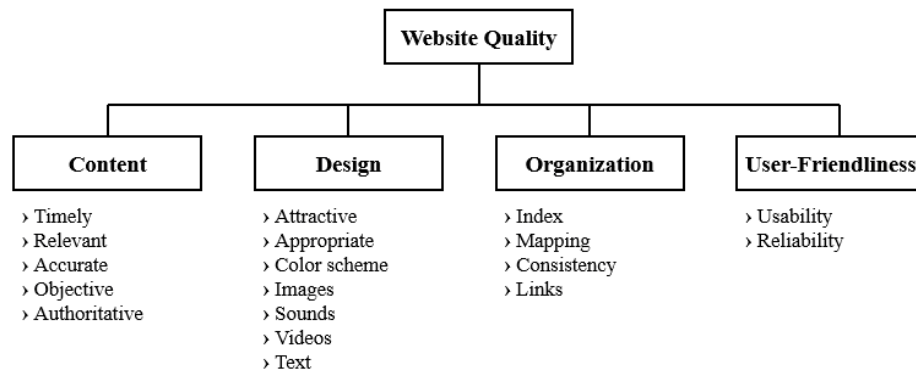
3

Figure 1 Model of criteria for eCritical Comparison of the Quality and Content of Integrated Vascular Surgery, Thoracic Surgery and Interventional Radiology Residency Training Program Websitesaluating website quality (adapted from Hasan and Abuelrub [30]).

Table 2 Accessibility of integrated vascular surgery, integrated thoracic surgery, and integrated interventional radiology training program websites from the ACGME webpage.

	Vascular Surgery	Thoracic Surgery	Interventional Radiology	P Value
No. of programs	61	27	85	
No. of providing website links (%)	53 (86.9)	24 (88.9)	81 (95.3)	0.182
No. of functioning links (%)	47 (88.7)	21 (87.5)	74 (91.4)	0.244
No. of direct links (%)	17 (36.2)	7 (33.3)	17 (23.0)	0.521
ACGME, Accreditation Council for Graduate Medical Education. ACGME links were accessed November 2019.				

Table 3 Availability of content on U.S. integrated vascular surgery, integrated thoracic surgery, and integrated interventional radiology training program websites.

	Vascular Surgery No. (%) of programs (n = 56)	Thoracic Surgery No. (%) of programs (n = 27)	Interventional Radiology No. (%) of programs (n = 74)	P Value
Program recruitment				
Program description	56 (100.0)	26 (96.3)	69 (93.2)	0.138
Faculty listing	53 (94.6)	27 (100.0)	73 (98.6)	0.233
Faculty education (training history)	52 (92.9)	25 (92.6)	68 (91.9)	0.978
Admin/coordinator contact	53 (94.6)	22 (81.5)	63 (85.1)	0.137
Faculty profile (descriptive)	46 (82.1)	19 (70.4)	68 (91.9)	**0.023**
Application requirements	42 (75.0)	22 (81.5)	50 (67.6)	0.337
ERAS link	35 (62.5)	16 (59.3)	47 (63.5)	0.926
If present, is ERAS link functional?	35 (62.5)	16 (59.3)	47 (63.5)	0.926
Benefits	39 (69.6)	19 (70.4)	51 (68.9)	0.989
Facility description	50 (89.3)	22 (81.5)	49 (66.2)	**0.007**
No. incoming positions available	44 (78.6)	20 (74.1)	45 (60.8)	0.079
Salary	34 (60.7)	17 (63.0)	48 (64.9)	0.889
Current residents	40 (71.4)	20 (74.1)	47 (63.5)	0.485
Vacation policy	32 (57.1)	18 (66.7)	46 (62.2)	0.685
Program director contact	24 (42.9)	8 (29.6)	43 (58.1)	**0.026**
Faculty publications	24 (42.9)	19 (70.4)	40 (54.1)	0.060
Wellbeing strategies	26 (46.4)	17 (63.0)	37 (50.0)	0.360
City information	33 (58.9)	16 (59.3)	35 (47.3)	0.338
Educational fund	19 (33.9)	12 (44.4)	35 (47.3)	0.299
Resident education history	35 (62.5)	17 (63.0)	34 (45.9)	0.110
Parking	17 (30.4)	9 (33.3)	34 (45.9)	0.164
Domestic considerations	32 (57.1)	16 (59.3)	32 (43.2)	0.186
VISA	22 (39.3)	12 (44.4)	32 (43.2)	0.868
Interview dates	32 (57.1)	13 (48.1)	29 (39.2)	0.126
Faculty contact information	17 (30.4)	9 (33.3)	27 (36.5)	0.764
Meal allowance	16 (28.6)	11 (40.7)	27 (36.5)	0.480

Sample contract	9 (16.1)	7 (25.9)	21 (28.4)	0.249
Call requirement	22 (39.3)	16 (59.3)	21 (28.4)	**0.017**
Program director message	17 (30.4)	3 (11.1)	18 (24.3)	0.159
Resident profiles	10 (17.9)	7 (25.9)	18 (24.3)	0.601
Interview details	10 (17.9)	5 (18.5)	18 (24.3)	0.629
Alumni listing	20 (35.7)	7 (25.9)	17 (23.0)	0.268
Alumni career placement	15 (26.8)	6 (22.2)	17 (23.0)	0.851
Selection process	4 (7.1)	2 (7.4)	13 (17.6)	0.140
Debt management	22 (39.3)	11 (40.7)	8 (10.8)	**<0.001**
Resident contact information	5 (8.9)	3 (11.1)	6 (8.1)	0.896
Work hours	12 (21.4)	12 (44.4)	6 (8.1)	**<0.001**
Alumni education history	7 (12.5)	1 (3.7)	2 (2.7)	0.063
Alumni contact information	1 (1.8)	0 (0.0)	1 (1.4)	0.791
Program chair message	5 (8.9)	2 (7.4)	1 (1.4)	0.126
Board examination performance	4 (7.1)	0 (0.0)	1 (1.4)	0.103
Program education				
Rotation schedule	47 (83.9)	19 (70.4)	45 (60.8)	**0.016**
Research interests (department)	22 (39.3)	16 (59.3)	49 (66.2)	**0.008**
Didactic instruction	39 (69.6)	17 (63.0)	42 (56.8)	0.323
Research requirements	41 (73.2)	19 (70.4)	39 (52.7)	**0.039**
Operative experience	18 (32.1)	5 (18.5)	37 (50.0)	**0.008**
Journal club	34 (60.7)	11 (40.7)	25 (33.8)	**0.008**
Meetings attended	26 (46.4)	11 (40.7)	23 (31.1)	0.195
Elective rotation	25 (44.6)	12 (44.4)	20 (27.0)	0.074
Conference schedule	21 (37.5)	6 (22.2)	18 (24.3)	0.186
Curriculum	21 (37.5)	10 (37.0)	12 (16.2)	**0.012**
Faculty mentorship	6 (10.7)	3 (11.1)	11 (14.9)	0.751
Vascular lab	36 (64.3)	2 (7.4)	10 (13.5)	**<0.001**
National organization link	4 (7.1)	7 (25.9)	8 (10.8)	**0.044**
Evaluation criteria	9 (16.1)	6 (22.2)	5 (6.8)	0.077
Simulation training	19 (33.9)	9 (33.3)	3 (4.1)	**<0.001**
Company link	2 (3.6)	1 (3.7)	0 (0.0)	0.256
ERAS, Electronic Residency Application Service				

(11%). Almost no programs provided information on national organization links (7%) and cardiovascular product company links (4%).

Thoracic surgery: For program recruitment, almost all programs provided information on program description (96%), faculty listing (100%), faculty education (93%), administrator or coordinator contact information (82%), facility description (82%), and application requirements (82%). The majority of programs provided information on descriptive faculty profiles (70%), a link to ERAS (59%), ERAS link was functional (59%), benefits (70%), the number of incoming positions available (74%), salary (63%), current residents (74%), faculty publications (70%), wellbeing strategies (63%), city information (59%), resident education history (63%), vacation policy (67%), call requirement (59%), and domestic considerations (59%). Less than one-half of programs provided information on program director contact information (30%), interview dates (48%), faculty contact information (33%), sample contracts (26%), resident profiles (26%), alumni listings (26%), debt management (41%), educational fund (44%), parking (33%), non-national visa information (44%), meal allowance (41%), and work hours (44%). Fewer than one-quarter of programs provided information on program director message (11%), alumni career placement (22%), interview details (19%),

and resident contact information (11%). Almost no programs provided information on selection process (7%), alumni education history (4%), program chair message (7%), board examination performance (0%), and alumni contact information (0%).

For program education, the majority of programs provided information on rotation schedule (70%), departmental research interests (59%), didactic instruction (63%), and research requirements (70%). Less than one-half of programs provided information on journal club (41%), meetings attended (41%), elective rotations (44%), curriculum (37%), national organization links (26%), and simulation training (33%). Fewer than one-quarter of programs provided information on operative experiences (19%), conference schedule (22%), faculty mentorship (11%), and evaluation criteria (22%). Almost no programs provided information on vascular lab training (RPVI; 7%) as would be expected for Thoracic Surgery.

Interventional radiology: For program recruitment, almost all programs provided information on program description (93%), faculty listing (99%), faculty education (92%), administrator or coordinator contact information (85%), and descriptive faculty profiles (92%). The majority of programs provided information on

Table 4 Quality of U.S. integrated vascular surgery, integrated thoracic surgery, and integrated interventional radiology training program websites: mean ± standard deviation.

	Content	Design	Organization	User friendliness	Average quality
Vascular Surgery	2.57 ± 0.95	2.59 ± 0.99	2.75 ± 0.96	2.73 ± 0.90	2.66 ± 0.95
Thoracic Surgery	2.04 ± 0.85	2.22 ± 0.89	2.19 ± 1.08	2.26 ± 0.86	2.18 ± 0.92
Interventional Radiology	2.27 ± 0.90	2.05 ± 0.77	2.32 ± 0.97	2.34 ± 0.88	2.25 ± 0.88
1, poor; 2, acceptable; 3, good; 4, great.					

application requirements (68%), a link to ERAS (64%), ERAS link was functional (64%), facility description (66%), vacation policy (62%), benefits (69%), the number of incoming positions available (61%), salary (65%), current residents (64%), program director contact information (58%), and faculty publications (54%). Less than one-half of programs provided information on wellbeing strategies (50%), city information (47%), educational fund (47%), parking (46%), non-national visa information (43%), meal allowance (37%), call requirement (24%), resident education history (46%), domestic considerations (43%), interview dates (39%), faculty contact information (37%), and sample contracts (28%). Fewer than one-quarter of programs provided information on program director message (24%), resident profiles (24%), interview details (24%), alumni listing (23%), alumni career placement (23%), selection process (18%), and debt management (11%). Almost no programs provided information on resident contact information (8%), work hours (8%), alumni education history (3%), program chair message (1%), board examination performance (1%), and alumni contact information (1%).

For program education, the majority of programs provided information on rotation schedule (61%), departmental research interests (66%), didactic instruction (57%), and research requirements (53%). Less than one-half of programs provided information on operative experiences (50%), journal club (34%), meetings attended (31%), and elective rotations (27%). Fewer than one-quarter of programs provided information on conference schedule (24%), curriculum (16%), faculty mentorship (15%), vascular lab training (RPVI; 14%), and national organization links (11%). Almost no programs provided information on evaluation criteria (7%), simulation training (4%), and cardiovascular product company links (0%).

Comparison of content availability: Vascular surgery webpages provided the most information on rotation schedule (84%), journal club (61%), and vascular lab (64%) as compared to thoracic surgery (70%, 41%, and 7%) and interventional radiology (61%, 34%, and 14%) webpages (P=0.016, P=0.008, and P<0.001). Vascular surgery webpages provided less information on departmental research interests (39%) as compared to thoracic surgery (59%) and interventional radiology (66%) webpages (P=0.008).

Thoracic surgery webpages provided the most information on call requirement (59%), national organization link (26%), and work hours (44%) as compared to vascular surgery (39%, 7%, and 21%) and interventional radiology (28%, 11%, and 8%) webpages (P=0.017, P=0.044, P<0.001). Thoracic surgery webpages provided less information on descriptive faculty profiles (70%) as compared to vascular surgery (82%) and interventional radiology (92%) webpages (P=0.023).

Interventional radiology webpages provided the most information on operative experience (50%) and program director contact information (58%) as compared to vascular surgery (32% and 43%) and thoracic surgery (19% and 30%) webpages (P=0.008 and P=0.026). Interventional radiology webpages provided less information on facility description (66%), debt management (11%, P=0.007,), research requirements (53%, P<0.001), curriculum (16%, P=0.039), and simulation training (4%, P<0.001) as compared to vascular surgery (89%, 39%, 73%, 38%, and 34%) and thoracic surgery (82%, 41%, 70%, 37%, and 33%) webpages respectively.

Quality of websites: On an overall assessment, integrated vascular surgery, thoracic surgery, and interventional radiology websites were found to be comparable. The average and standard deviation vascular surgery website score was 2.66 ± 0.95, the average and standard deviation thoracic surgery website score was 2.18 ± 0.92, and the average and standard deviation interventional radiology website score was 2.25 ± 0.88. The vascular surgery websites had the highest scores in content, design, organization, and user-friendliness. The thoracic surgery websites had the lowest scores in content, organization, and user-friendliness while the interventional radiology websites had the lowest score in design. Additional details regarding website quality, broken down by category, are visible in **Table 4**.

Discussion

As resident recruitment moves to a virtual platform, the internet is an increasingly important resource for residency applicants as they research programs. Thoracic surgery program webpages had the most information, then vascular surgery program webpages, with interventional radiology program webpages reporting the least content. This trend in availability of content items mirrors the percent of positions filled by each specialty, with 100% of PGY-1 thoracic surgery positions filled, 97% of vascular surgery PGY-1 positions filled, and 97% of PGY-1 interventional radiology positions filled (with 94% of PGY-2 interventional radiology positions filled), as reported by the NRMP 2020 Main Residency Match Results and Data report [22].

Other factors, beyond program websites, that have been identified to influence applicant interest in a program, include geography, advice from a mentor, advice from a peer, and other online information. The integrated vascular track was first accredited by the ACGME in 2006, [21] the first integrated thoracic surgery program accepted residents in 2007, [23] and the first integrated interventional radiology programs participated in the National Resident Matching Program (NRMP) in 2016 [24]. The majority of these integrated programs have been established for less than ten years. This increase in the number of integrated programs,

though necessary to meet the high demand for integrated residency positions, means that many programs do not have an established national presence. Applicants cannot receive the same quality of advice from mentors and peers on newer programs, as compared to programs that have been established for longer periods of time. Furthermore, many programs are geographically clustered, specifically in the Northeast and along the West coast (see Supplemental **Figure 1**). These factors combine to place additional weight on program websites, perhaps serving as the initial source of information for potential applicants and allowing for comparison.

Of ACGME accredited programs, 56 of 61 (92%) vascular surgery programs, 27 of 27 (100%) thoracic surgery programs, and 74 of 85 (87%) interventional radiology programs had functional websites. Thoracic surgery program webpages had the most information (content item median: 27, IQR: 21, 32), then vascular surgery program webpages (content item median: 26, IQR: 20, 32), with interventional radiology program webpages reporting the least content (content item median: 23, IQR: 18, 27). The greater amount of content on vascular surgery and thoracic surgery program webpages could be expected, given the young age of many interventional radiology programs. Previous studies have acknowledged integrated interventional radiology program webpages to be a work in progress [11]. This study confirms that finding in relation to longer-established vascular surgery and thoracic surgery program webpages.

Two content items that have been identified to be highly influential to applicant program decision are operative experience and faculty mentorship [25-27]. This analysis found those items to be reported at 32% and 11% for vascular surgery, 19% and 11% for thoracic surgery, and 50% and 15% for interventional radiology programs (P=0.008 and P=0.751, respectively). Additional notable deficits for vascular surgery websites were resident profiles, sample contracts, and departmental research interests. Thoracic surgery websites lacked program director contact information and message as well as information on operative experience. Interventional radiology websites had deficits in work hours, debt management, and curriculum. All specialty websites had deficits in evaluation criteria and faculty mentorship. In addition to addressing the deficits in program recruitment and education content items, the deficits in lifestyle management cannot be disregarded; medical students increasingly report controllable lifestyle as a major factor in specialty choice [28-30].

The deficits identified by this analysis are comparable to deficits identified for other specialties. Other studies have found considerable deficits in newsletter, resident listings and photographs, faculty contact information, and away elective rotation information for dermatology websites, [3] resident call schedule, alumni career placement, and salary for orthopedic surgery websites, [6] academic conference schedule, call schedule, operative case listing, graduate fellowship information, and board exam performance for plastic surgery websites, [14]

evaluation criteria, call schedule, operative exposure, national meetings attended, debt management, alumni contact, and work hours for neurosurgery websites, [15] call schedule, away elective rotation information, resident profiles, and faculty research for general surgery websites, [16] and call schedule, active/past research projects, area information, message from the program director or chair, selection criteria, salary, and surgical statistics for otolaryngology websites [17].

Overall, we recommend that programs address the deficits in specific content items identified by this analysis. Given the increasingly important role of online information in the residency application process and the anticipated transition to a virtual application process for the 2021 cycle, it would behoove programs to increase their online presence. In addition to the content items included in this analysis, it might be fitting for programs to include more personal information (i.e. more detailed resident and attending profiles) to give applicants a better idea of the personality of different programs, replacing the role previously served by in-person away rotations and interviews.

This study had several limitations. First, this data is representative of what information was available online at the time of data collection. It is possible that websites could have been edited or new program websites could have been published since that time. Additionally, though an extensive list of content items were evaluated by reviewers regarding program recruitment and education, it is possible that other, unmentioned content items could hold bearing on applicant decision. Finally, reviewers were not blinded to what program they were evaluating. Thus, any inherent bias reviewers might have had for particular programs was not controlled for. The nature of this study did not lend itself to evaluating the association between website content, to what specialty and to what programs applicants apply, and ultimate applicant program placement. Future studies could seek to characterize this trajectory.

Conclusion

This study has uncovered key differences in availability of online content for residency programs recruiting from the same pool of applicants. Thoracic surgery program webpages have the most information, then vascular surgery program webpages, with interventional radiology program webpages reporting the least content. Recruitment is highly competitive between vascular surgery, thoracic surgery, and interventional radiology with the ratio of applicants to positions being highest for thoracic surgery, then interventional radiology and lastly vascular surgery, as reported by ERAS. To attract valuable candidates, programs should aim to increase the availability of online content for potential applicants.

Funding

References

1   Powell RJ, Brown KR, Davies MG, Hart JP, Hsu JH, et al. (2020) The value of the modern vascular surgeon to the health care system: a report from the society for vascular surgery valuation work group. J Vasc Surg.

2   Veith FJ (2016) A look at the future of vascular surgery. J Vasc Surg 64:885-890.

3   Ashack KA, Burton KA, Soh JM, Lanoue J, Boyd AH, et al. (2016) Evaluating dermatology residency program websites. Dermatol Online J 22.

4   Oladeji LO, Jonathan CY, Oladeji AK, Ponce BA (2015) How useful are orthopedic surgery residency web pages? J Surg Educ 72:1185-1189.

5   Rozental TD, Lonner JH, Parekh SG (2001) The internet as a communication tool for academic orthopaedic surgery departments in the United States. J Bone Joint Surg 83:987-991.

6   Davidson AR, Loftis CM, Throckmorton TW, Kelly DM (2016) Accessibility and availability of online information for orthopedic surgery residency programs. Iowa Ortho J 36:31.

7   Hashmi A, Policherla R, Campbell H, Khan FA, Schumaier A, et al. (2017) How informative are the plastic surgery residency websites to prospective applicants? J Surg Educ 74:74-78.

8   Miller VM, Padilla LA, Schuh A, Mauchley D, Cleveland D, et al. (2020) Evaluation of cardiothoracic surgery residency and fellowship program websites. J Surg Res 246:200-206.

9   Mahler SA, Wagner M-J, Church A, Sokolosky M, Cline DM (2009) Importance of residency program web sites to emergency medicine applicants. J Emerg Med 36:83-88.

10   Mulcahey MK, Gosselin MM, Fadale PD (2013) Evaluation of the content and accessibility of web sites for accredited orthopaedic sports medicine fellowships. J Bone Joint Surg 95:e85.

11   Novin S, Yi PH, Vanderplas T, Yim D, Hong K (2018) Integrated interventional radiology residency program websites: a development in progress. Am J Roentgen 211:211-216.

12   Reilly EF, Leibrandt TJ, Zonno AJ, Simpson MC, Morris JB (2004) General surgery residency program websites: usefulness and usability for resident applicants. Curr Surg 61:236-240.

13   Shaath MK, Yeranosian MG, Ippolito JA, Adams MR, Sirkin MS, et al. (2018) Evaluation of the content and accessibility of web sites for accredited orthopaedic trauma surgery fellowships. J Bone Joint Surg 100:e60.

14   Silvestre J, Tomlinson-Hansen S, Fosnot J, Taylor JA (2014) Plastic surgery residency websites: a critical analysis of accessibility and content. Ann Plast Surg 72:265-269.

15   Skovrlj B, Silvestre J, Ibeh C, Abbatematteo JM, Mocco J (2015) Neurosurgery residency websites: a critical evaluation. World Neurosurg 84:727-733.

16   Stoeger SM, Freeman H, Bitter B, Helmer SD, Reyes J, et al. (2019) Evaluation of general surgery residency program websites. Am J Surg 217:794-799.

17   Svider PF, Gupta A, Johnson AP, Zuliani G, Shkoukani MA, et al. (2014) Evaluation of otolaryngology residency program websites. JAMA Otolaryngol-Head & Neck Surg 140:956-960.

18   Cantrell CK, Dahlgren NJ, Young BL, Hendershot KM (2018) Evaluation of accredited trauma, surgical critical care, and acute care surgery fellowship websites. J Surg Res 232:160-163.

19   Ahmed SA, Hyman C, Eltorai AE, Ahn SH (2019) Evaluation of integrated interventional radiology residency websites. Rhode Island Med J 102:19-23.

20   Charalel RA, Pua BB, Galla N, Trehan SK, Madoff DC (2016) Interventional radiology fellowship website content: what is the relevance to potential applicants? Clin Imag 40:1070-1074.

21   Huang BY, Hicks TD, Haidar GM, Pounds LL, Davies MG (2017) An evaluation of the availability, accessibility, and quality of online content of vascular surgery training program websites for residency and fellowship applicants. J Vasc Surg 66:1892-1901.

22   Program NRM (2020) Results and data: 2020 main residency match. 2020.

23   Lebastchi AH, Tackett JJ, Argenziano M, Calhoon JH, Gasparri MG, et al. (2014) First nationwide survey of US integrated 6-year cardiothoracic surgical residency program directors. J Thorac Cardiovasc Surg 148:408-415.

24   Marx VM (2020) Evolution of interventional radiology and abr certification: birth of the abr certification in interventional radiology and diagnostic radiology. Society of Inter Radiol.

25   Lee JT, Teshome M, De Virgilio C, Ishaque B, Qiu M, et al. (2010) A survey of demographics, motivations, and backgrounds among applicants to the integrated 0+5 vascular surgery residency. J Vasc Surg 51:496-503.

26   Calligaro KD, Dougherty MJ (2006) Choice of vascular surgery as a specialty: what is important? Paper presented at: Seminars in vascular surgery.

27   Calligaro KD, Dougherty MJ, Sidawy AN, Cronenwett JL (2004) Choice of vascular surgery as a specialty: survey of vascular surgery residents, general surgery chief residents, and medical students at hospitals with vascular surgery training programs. J Vasc Surg 40:978-984.

28   Resneck Jr JS (2006) The influence of controllable lifestyle on medical student specialty choice. AMA J Ethics 8:529-532.

29   Dorsey ER, Jarjoura D, Rutecki GW (2003) Influence of controllable lifestyle on recent trends in specialty choice by US medical students. J Am Med Assoc 290:1173-1178.

30   Hasan L, Abuelrub E (2011) Assessing the quality of web sites. App Comp Inform 9:11-29.