Title of Manuscript: Website Usability Analysis of United States Emergency Medicine Residencies

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Running Title: Website Usability Analysis of US EM Residencies

Keywords: website usability; emergency medicine residencies; healthcare website; usability testing; web crawler; digital health

Word Count: 3,767

Prior Presentations: Abstract presented at the American College of Emergency Physicians Research Forum (Virtual Conference), October 26-29th 2020

Financial Support: None

Author contributions:

Study Concept and Design: JC, SH, DL

Acquisition of Data: EF, JF

Analysis and Interpretation of Data: EF, JF, JC, AR, DL, SS, MH, TC, SH

Drafting of the Manuscript: EF, JF, JC, AR, DL, SS, MH, TC, SH

Critical Revision of the Manuscript for Important Intellectual Content: EF, JF, JC, AR, DL, SS, MH, TC, SH

Statistical Expertise: AR, DL, SS, MH, TC, SH

Acquisition of Funding: N/A

Conflict of Interest Disclosure:

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No other disclosures are reported

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No other disclosures are reported

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Honoraria: University of British Columbia, University of Manitoba, ALiEM, LLC

Salary: McMaster University

No other disclosures are reported

SH reports:

Advisory Board: Covid Act Now, Safeter.App

Board of Directors: Cofounder, Executive Board Director GetUsPPE, Co-Founder, Executive Board ConductScience LLC

Committees: American College of Emergency Physician Supply Chain Task Force

Research Funding: Foundation for Opioid Response Efforts (FORE)

Royalties: MazeEngineers LLC

Consulting: Withings inc

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No other disclosures are reported

Acknowledgments: None

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Article type : Original Contribution

Title: **Website Usability Analysis of United States Emergency Medicine Residencies**

Abstract

Objectives:

The Council of Residency Directors (CORD) in Emergency Medicine (EM) has recommended that all residency programs should conduct virtual interviews for the 2020-2021 application cycle due to the COVID-19 pandemic. While factors such as geographical region, city, program size or hospital affiliation are not modifiable, EM residencies can bridge the information gap created by a lack of face-to-face interaction by representing themselves digitally. Measuring usability provides an objective method for EM residencies to improve their web presence and effectively represent themselves to applicants.

Methods:

Our sample set included 55 United States EM residency program websites. Using methodology replicated from previous literature on healthcare website usability[1], we divided usability into four categories for quantifiable analysis: Accessibility, Marketing, Content Quality, and Technology. Analysis was performed on each website and scored in all four categories. A "General Usability" score was calculated for each website using a composite of the key factors within the four categories. Using a weighted percentage across all of the factors, an overall score was calculated.

Results:

Content Quality was the overall highest scoring category (mean 5.4, SD 2.48, SE 0.33). The overall lowest performing category was Technology (mean 0.8, SD 0.09, SE 0.01).

Conclusions:

Measuring usability can help EM residency programs identify ways to improve their web presence. To effectively promote their programs, residencies need quality content that communicates their key features. Our recommendation is for all residency programs to periodically perform website audits and apply the usability measures outlined in order to improve their digital presence, especially during times when face-to-face interactions will be limited.

Introduction

Background

With COVID-19 upending the traditional residency application process, residency programs and medical students are finding themselves needing to adapt to changes in the 2020-2021 cycle. This is primarily due to fewer opportunities for in-person contact and communication. The Coalition for Physician Accountability has made several recommendations in an effort to minimize in-person interaction with residency programs including the limitation of away rotations, conduction of virtual interviews, and virtual orientation and tours. [2] The Council of Residency Directors (CORD) in Emergency Medicine (EM) has recommended that all EM residency programs conduct their interviews virtually.[3] Similarly, the Association of Faculties of Medicine of Canada Resident Matching Committee (ARMC) decided that all interviews for the 2021 Medicine Subspecialty Match, Pediatric Subspecialty Match, and Family Medicine/Enhanced Skills Match will be in a virtual format including those for local candidates.[4] Traditionally, EM residency interviews have allowed programs to showcase their cities and facilities. Interviews have also conventionally offered students and programs the opportunity to interact socially through events such as mixers and/or dinners. These factors remain difficult to overcome virtually. Additionally, CORD has recommended that students and EM residency programs work to minimize the amount of visiting student rotations, to reduce the amount of

travel during this pandemic.[3] Although two EM rotations including one home and one "away" or "visiting" clerkship was the pre-COVID-19 standard recommendation for medical students, students may now only be able to rotate at their home program.[5] Visiting student rotations have traditionally afforded more contact between applicants, personnel, and programs, allowing for improved assessment of compatibility. These rotations give students the chance to learn the setting (i.e. county, community, academic) they prefer and augment their perception of overall "fit".[6] Due to these changes, both students and EM residency programs will make high-stakes decisions with less information than in previous years. Although programs cannot change the circumstances surrounding COVID-19 or their own non-modifiable factors (i.e. geographical region, city, program size, hospital affiliation), they can better represent themselves digitally via their websites and social media. A residency program's website is often their first impression on an applicant. Although the content contained on the website is crucial, the manner in which this content is presented is also important. Understanding the technical aspects of website usability can help one website stand out from another and should not be overlooked when building a website. With a lack of face-to-face interaction, programs can minimize the information gap by enhancing their website usability.

Website Usability for EM Residency Programs

Usability extends beyond a website's external appearance; it also encompasses variables of "user experience" including website errors and overall ease of navigation.[7] Previous research has analyzed usability in e-commerce, e-government, mobile news apps, and library websites.[8–11] With regards to healthcare-related websites, usability has been analyzed in hospital, children's hospital, cancer center, and digital healthcare center websites.[1,12–14] A website with enhanced usability tends to garner higher levels of engagement, and therefore better accomplishes its goals.[15–17] Accordingly, industries outside of healthcare have established standardized guidelines for measuring usability in the areas of Accessibility, Content Quality, Marketing, and Technology.[15–17] Expectations of user experience have been established, and healthcare websites are facing pressures to conform to these requirements.[18,19]

As EM residency program websites will now play a larger role than ever in recruiting potential applicants, the importance of evaluating and optimizing usability has increased. Residency

program websites have previously been analyzed for content quality within the specialties of general surgery, neurosurgery, diagnostic and interventional radiology, dermatology, physical medicine and rehabilitation, cardiothoracic surgery, urology, orthopedic surgery, otolaryngology, plastic surgery, vascular surgery, and radiation oncology.[19-29] To our knowledge, no prior analysis of EM residency website usability has been performed. This analysis may inform EM residencies how to improve their online presence and more effectively represent themselves to potential applicants.

Objectives

Aim 1: Categorize EM residency programs and their websites. **Aim 2**: Utilize a previously published usability scoring system to objectively and quantitatively analyze their websites.[1] **Aim 3**: Identify themes to suggest areas of improvement amongst EM residency websites.

Methods

We conducted a cross-sectional usability audit of U.S. EM residency websites.

Sample selection

Our target website population was United States EM residency programs. We started with 251 programs that were listed as Accreditation Council for Graduate Medical Education (ACGME) accredited on the Electronic Residency Application Service (ERAS) website. We refined our sample set by only including programs that use their own primary domain or subdomain. Programs using a subpage of a larger domain (i.e. hospital or university) were excluded as the analysis would include non-residency related content (i.e. patient care, patient portals, residency programs other than EM etc.). Without using the exclusion criteria there would likely be artificially high scores for pages with a large primary domain that added a small residency subpage. Websites that were inconclusive or showed errors upon analysis were also excluded. Our final sample set included 55 U.S. EM residency programs. This process is represented in Figure 1.

Overview

All data was collected between 27 May 2020 and 7 June 2020 using tools that assessed the website usability of each program. We replicated a methodology that was previously outlined by Calvano et. al. who ranked the usability of digital healthcare center websites.[1] We maintained the definitions and scoring system described by Calvano et al. and applied the same formulas to determine the usability of the websites assessed in our study. The four categories that were identified and defined in previous literature as aspects of usability are:

1) Accessibility - ability of users with lower levels of computer literacy to access and navigate the website.
2) Marketing – ability of the website to be found through search engines.
3) Content Quality – lack of grammatical errors, frequency of content updates, content relevancy, and readability.
4) Technology – website download speed, quality of the programming code, and website infrastructure. [1,12,13]

Analysis

We built a database of ACGME accredited EM residency program websites that used their own primary domain or subdomain. We then scored each website according to a variety of usability tools outlined thoroughly by Calvano et. al. in Table S1. These tools were selected based on the ability of the tool to analyze a given target factor (ie. website speed) in a user-friendly way. The primary tool used for website evaluation was a "web crawler". A web crawler uses the websites URL to create a topographical map of a website and its subpages in order to analyze it for errors, content, and metadata including: titles, keywords, and descriptions.[31] There were two authors involved in data gathering and rating who were thoroughly trained by an expert. Both raters familiarized themselves with the instruction manuals associated with each tool to ensure an accurate and reproducible analysis. The same two authors then divided the tools amongst themselves with only one author assigned to each tool and collected data for their given set of tools. This ensured that the data gathered using a certain tool was not influenced by different computer capabilities or internet connections, thereby minimizing potential discrepancies.

Factors that may rely on the users' internet connection (ie. speed) were run using two different tools and averaged in order to provide fair and accurate values.

The resulting scores given by each tool were then assigned to one of four categories: 1) Accessibility; 2) Content; 3) Marketing; 4) Technology. A "General Usability" score was calculated using a combination of key factors relating to each of the four categories. Finally, an "Overall Usability" score, which looked at variables across the previous categories, was used to provide a ranking system. A description, information about the rating scale, and the significance of each category are described in Table S1, which Calvano et al. provided for our explicit use.

Accessibility

Accessibility is a category intended to represent how well a website caters to a diverse population, regardless of the level of literacy, technical skills, or presence of disabilities. Accessibility includes the following variables: meta description, functionality, readability, and overall layout. Meta description refers to the "snippet" page summary that appears when a site is the result of a search engine inquiry. Functionality looks at features allowing users to view aspects of a website with content levels appropriate for user understanding, regardless of their literacy levels. An estimated 43% of American adults have been observed to have basic or below basic literacy rates.[32] The use of assistive technologies also falls under Accessibility. This refers to features such as screen readers/magnifiers of a website.[33] By using tools to apply algorithmic scales, the websites were ranked on their level of reading difficulty as well as approximating the grade level required for content comprehension in order to grade Accessibility.

Content Quality

Content Quality assesses both the positive and negative elements of a website's published content. Content Quality includes the following variables: information relevance, generated metadata, use of multimedia for imagery, and relevancy of written text. Relevancy refers to the content's pertinence and accuracy to a particular topic at a specific point in time. In our context, websites dedicated to presenting information about an EM residency program were evaluated on the ability to provide both relevant and accurate information to applicants (i.e. application requirements, curriculum details, benefits). Evaluation of multimedia addresses both quantity

and quality (i.e. resolution) of a website's multimedia. Metadata function adds support to the composed content. Analysis of written text looks at both grammar and spelling.

Marketing

Marketing addresses the ease of discovery of a particular website. There is specific emphasis on its Search Engine Results Pages (SERP). When internet users place an online search via a search engine (i.e. Google), SERP refers to the order in which websites are presented to the user. Websites that present higher on the list have increased visibility making SERPs a crucial factor in digital marketing. Search Engine Optimization (SEO) is an entire field dedicated to the optimization of this practice. SEO is an effective way healthcare websites, including EM residency programs, can create a similar corporate presence to other industries. The specifics of SEO auditing, however, are outside of the scope of this study.

Technology

Technology evaluates a website's technical functionality. Rather than content, it looks at the quality of technological design and performance. This includes front-end design, user experience, back-end coding infrastructure, and server management. Front-end design refers to what is visible to users browsing a website. Analysis of front-end design includes looking at aspects of hypertext markup language (HTML), which assesses the ease of navigation based on layout and how well a website is scalable across different devices (i.e. computers, tablets, and mobile phones). Back-end design includes the programming code which runs the website. Programming code and other web components (i.e. databases) are stored on servers which allows user-access on any suitable device. Additionally, the speed of a site (amount of time it takes to load) is server-dependent. This plays an important part in adding and maintaining users. According to a recent Google study, a website that takes longer than 3 seconds to load on a mobile device loses approximately 53% of its users and the average mobile website speed is around 18 seconds.[34]

General Usability

General Usability encompasses the metrics from the previous four categories. This score assesses the overall quality of a website and provides a point of reference for EM residencies to

begin an audit of their websites. The more specific categories allow them to look for areas of improvement.

Overall Usability

Overall Usability is the rank order calculation we used for complete assessment of all major and minor variables across the five previous categories. Percentages were assigned accordingly to create a weighted, comprehensive usability ranking system.

Results

Due to individual technical issues on specific websites, 6 websites were eliminated from our original set of 61. Most of these issues were related to errors with the web crawler, potentially due to the lack of index restrictions put in place by the website administrators. Scores were assigned to the remaining (N=55) EM residency websites.

Accessibility had a mean score of 1.9 (Standard Deviation (SD) 0.62) (Standard Error (SE) 0.08). Content Quality was the highest average scoring category by a significant margin with a score of 5.4 (SD 2.48) (SE 0.33). Marketing had a mean score of 1.3 (SD 0.48) (SE 0.06). The overall lowest performing category was Technology, with a mean score of 0.7 (SD 0.09) (SE 0.01). General Usability had a mean score of 1.3 (SD 0.39) (SE 0.05). Summary statistics of all categories are shown in Table 1.

The overall rankings for the 55 assessed websites are presented in Table 2.

Leaders amongst ranking categories include: Accessibility - Christiana Care Health Services (3.5). Content Quality - Christiana Care Health Services (11.7). Marketing – There was a seven-way tie between Stanford University, UCLA David Geffen School of Medicine, University of Arkansas for Medical Sciences, University of California (Irvine), University of Florida College of Medicine Jacksonville, Virginia Commonwealth University Health Systems, and Washington University (2.1). Technology – There was a five-way tie between Brookdale University Hospital and Medical Center, Christiana Care Health Services, Tower Health, University of Arkansas for Medical Sciences, and the University of Florida College of Medicine Jacksonville (0.9). General

Usability - Christiana Care Health Services Program (2.4). The top ranked website for Overall Usability was also Christiana Care Health Services Program (3.2). For the categories that ended in a tie, the websites had scores within a 100^{th} of a decimal point. Table 2 does not reflect these as a tie.

Discussion

After thorough investigation of usability, the General Usability category was found to be low performing, indicating overall room for improvement amongst EM residency websites. Content Quality was the overall highest scoring category by a significant margin and Technology was the lowest performing category.

A low average General Usability score indicates that these EM residency programs do not have a complete understanding of usability metrics and what is necessary for overall website quality. This is resembled by the disproportionate scoring between the analyzed categories. On the surface, it is easy for programs to view the quality of their website simply based on their content. However, by utilizing usability analysis these websites can examine beyond what is on the surface and discover other aspects in which they can improve.

Regarding Content Quality, our data shows that EM residency websites have placed heavy emphasis on providing accurate and relevant information about their residency programs. This represents the notation that, from a logistical standpoint, EM residency websites are primarily concerned with their content. It is important to inform these programs, however, that Content Quality is only a partial contributor and other factors need to be addressed to improve General Usability. In the event that a program was looking to improve their content, they could start by performing frequent audits, making sure their content if up to date. They could also address if the information they are presenting is relevant to what applicants are looking for. Additionally, evaluating both the quality and quantity of their multimedia and confirming their websites do not contain spelling or grammatical errors will improve their overall Content Quality.

Technology being the lowest average ranked category suggests a lack of importance placed on digital and information technology amongst these residency programs. A lack of investment may be resembled by a lack of server capacity or infrequent website/social media audits. Increasing website speed is a method in which websites can instantly improve their technology score. Increasing speed can largely be achieved by minimizing the amount of conflicting technology on the back-end server. Additionally, efforts can be made to improve front end design by enhancing ease of navigation and making websites scalable across different devices. By working with experts in user experience and user interface design, websites can address these areas.

Our results show that Marketing also scored low amongst EM residency program websites. If looking for improvement, programs can work with experts in SEO in order to optimize their websites to become more discoverable via search engines. They can also increase efforts in promoting their websites via social media or other affiliated websites in order to increase their referral traffic. Promoting overall brand strength would also increase overall website traffic.

When comparing our research to similar studies done on different residency programs, the results are fairly consistent regardless of specialty. Although studies evaluated websites based on tools and/or metrics that differed from our methodology, all similar studies across residencies indicated that there needs to be improvement to website presence from most institutions.[19-29]

Our methods were a direct continuation of a study by Calvano et. al. that ranked the usability of digital healthcare center websites.[1] Previous research allowed the authors to compare usability trends in healthcare, including: digital healthcare centers, hospitals, and children's hospitals.[1,12,13] In previously published usability studies, Content Quality was also found to be the highest ranking category.[1,12,13] Healthcare organizations as a whole have placed emphasis on providing factual consumer scientific information. Overall, healthcare websites are primarily concerned with their content and therefore neglect other aspects of usability. Technology being our lowest average ranked category was also consistent with previous research.[1,12,13] This suggests a lack of importance placed on digital and information technology in the field of healthcare.

The biggest difference between our findings and previous findings was that an evaluation of children's hospital websites found Accessibility to be the lowest score category as opposed to

Technology.[13] Accessibility also ranked low in other previous studies.[1,12] In our study, Accessibility was found to be the second highest scoring category. It appears that EM residency programs have an increased understanding of the importance of Accessibility compared to other healthcare organizations, indicating that they may be focused on creating content that can be easily accessed and comprehended by a diverse population. However, if EM residency websites are looking to improve their Accessibility, they could focus on making their platforms easy to navigate, publish content that is easy to read for those with low literacy levels, and confirm compatibility with screen readers and magnifiers. An assumption could be made that individuals accessing residency websites likely have sufficient levels of education/literacy necessary for appropriate comprehension, and therefore this measure is unnecessary. However, one goal of this research was to promote a consistent standard of evaluation across websites, regardless of the website type. Standardization of website analysis in the healthcare sector has been neglected in many areas and this is an important practice in other industries.[15–17] Additionally, it is key to have a standardized framework for understanding equity for users such as applicants who speak English as a second language (i.e. international applicants) and the family members of applicants.

This data would benefit from future analysis comparing website usability between EM residency programs that were established pre-web (pre-1990) and post-web. This would address if pre-web programs are underperforming in usability metrics compared to later established programs and provide additional insight on the groups of residency programs that would benefit the most from improving their website usability.

Healthcare is evolving through technology to improve quality of care while decreasing costs.[35] For these reasons, usability has become an important method for analyzing website presence throughout the healthcare sector, including education and medical training. With additional pressures that COVID-19 is placing on this year's application cycle and interview season, EM residency web presence has become more important than ever.

Limitations

The authors recognize that this study includes limitations. Perhaps the largest being the amount of EM residency websites that the authors were able to accurately analyze. Out of the 251

ACGME accredited EM residencies, only 55 met the inclusion criteria. This was primarily due to a limitation in the methods. The website analysis tools evaluate a website's entire primary domain or subdomain while many EM residencies use a subpage of a larger domain (i.e. hospital or university). If these websites were included, data would have been generated based on the entire hospital/university's domain, most of which is not residency related. For example, a primary domain may have an estimated domain age of 30+ years, but the EM residency subpage may have only been added 10 years ago. This would have misrepresented the data and given these subpages ranking advantages, and thus were excluded.

Additionally, our sample of EM residency program websites only included each program's official, public website. Certain programs use separate websites/blogs that allow them to circumvent institutional IT blocks. Other programs have private/password protected websites that they only make available to applicants they plan to interview. Because there is not a standardized list containing these secondary websites, they would be tenuous to find and therefore we did not include them in our analysis. Due to this limitation, we believe it would be beneficial to include these websites into future studies.

A minor limitation was in the assessment of a website's social media presence. Some websites did not have direct links to their social media profiles. In these cases, Facebook and Twitter's self-hosted search engines were used. Oftentimes the desired page was distant from the top results. This created uncertainty as to whether all of the official social media pages were discovered and emphasizes the necessity of embedding social media links to improve user experience.

An additional limitation included the measurement of website speed. This measurement can be variable with dependence on the time of data collection. Depending on the time, there may be differences in the internet connectivity or changes to the website servers or computer hardware. This bias was minimized by using the same computer and network to run all of the tools.

Finally, data was collected over a span of 12 days meaning that some of the information may have changed since the initial evaluation.

Conclusion

In the 2020-2021 residency application cycle, the majority of medical students pursuing EM will make residency selection decisions without physically meeting program members or seeing facilities in-person. Many potential residents will be looking to a program's website and social media presence to gain a better understanding of their compatibility with the program. Our results provide EM residencies with areas upon which to focus improvement in website usability efforts. The need for overall refinement is highlighted by the average General Usability score of 1.3. Our data has identified that Content Quality is the highest rated usability category and Technology is the lowest. We recommend that EM residency programs include periodic usability audits of their websites to make sure they are adequately performing in all categories.

Abbreviations:

ACGME: Accreditation Council for Graduate Medical Education
ERAS: Electronic Residency Application Service
SEO: search engine optimization
SERP: search engine results page
HTML: hypertext markup language
CORD: Counsel of Residency Directors
EM: emergency medicine
SD: standard deviation
SE: standard error

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Table 1. EM residency websites: Summary statistics from usability analysis.

Category	Mean (SE[a])	Standard Deviation	Minimum	Maximum
Accessibility	1.9 (0.08)	0.62	0.6	3.5
Content Quality	5.4 (0.33)	2.48	0.2	11.7
Marketing	1.3 (0.06)	0.48	0.5	2.1
Technology	0.7 (0.01)	0.09	0.6	0.9
General Usability	1.3 (0.05)	0.39	0.5	2.4

[a]SE: Standard Error

Figure 1: Sample selection criteria for EM residency websites