KANSAS JOURNAL of MEDICINE

Original Research

Health Literacy Analytics of Accessible Patient Resources in Cardiovascular Medicine: What are Patients Wanting to Know?

Som P. Singh, M.D.[1,2], Aarya Ramprasad, B.A.[1], Anh Luu, B.A.[1], Rohma Zaidi, B.A.[1], Zoya Siddiqui, B.A.[1], Trung Pham, M.D., MBA[1]

[1]University of Missouri-Kansas City School of Medicine, Kansas City, MO

[2]University of Texas Health Sciences Center at Houston, Houston, TX

Received May 22, 2023; Accepted for publication Dec. 21, 2023; Published online Dec. 31, 2023
https://doi.org/10.17161/kjm.vol16.20554

ABSTRACT

Introduction. There remains an increasing utilization of internet-based resources as a first line of medical knowledge. Among patients with cardiovascular disease, these resources often are relied upon for numerous diagnostic and therapeutic modalities. However, the reliability of this information is not fully understood. The aim of this study was to provide a descriptive profile on the literacy quality, readability, and transparency of publicly available educational resources in cardiology.

Methods. The frequently asked questions and associated online educational articles on common cardiovascular diagnostic and therapeutic interventions were investigated using publicly available data from the Google RankBrain machine learning algorithm after applying inclusion and exclusion criteria. Independent raters evaluated questions for Rothwell's Classification and readability calculations.

Results. Collectively, 520 questions and articles were evaluated across 13 cardiac interventions, resulting in 3,120 readability scores. The sources of articles were most frequently from academic institutions followed by commercial sources. Most questions were classified as "Fact" at 76.0% (n = 395), and questions regarding "Technical Details" of each intervention were the most common subclassification at 56.3% (n = 293).

Conclusions. Our data show that patients most often are using online search query programs to seek information regarding specific knowledge of each cardiovascular intervention rather than form an evaluation of the intervention. Additionally, these online patient educational resources continue to not meet grade-level reading recommendations.

Kans J Med 2023;16:309-315

INTRODUCTION

Cardiovascular disease continues to remain a leading cause of morbidity and mortality among individuals throughout the world.[1] In the United States, healthcare expenditures on the management of this disease have increased by over 100 billion dollars in the past 20 years.[2] As a result, there is a continued investment of resources in innovative healthcare systems and processes that continue to transform cardiovascular patient care, including facets such as decision-making models, diagnostic and therapeutic interventions, and patient understanding of these innovations.[3] Regarding patient understanding, there remains an increasing utilization of internet-based resources as a first line of medical knowledge.[4] With the advancement of technology and the widespread availability of internet access, patients have the convenience to access an abundance of healthcare educational information at their fingertips, and the global utilization of these resources continues to expand. However, the navigation of this abundance can be an obstacle given the overwhelming amount of information unregulated for content accuracy, quality, readability, and transparency.[4-7] Therefore, it is vital to equip patients with the essential tools and education to actively participate in their informed decision-making process.

In cardiovascular medicine, patient education is pivotal in the management of diverse conditions such as hypertension, coronary artery disease, and heart failure. It also serves to inform patients about diagnostic and treatment modalities.[8,9] A critical component of patient education is health literacy. This concept is an individual's capacity to obtain healthcare information and interpret it in a manner that promotes the maintenance or enhancement of their health within a suitable context.[10] The literature consistently demonstrates that a decline in healthcare literacy or the presence of poor healthcare literacy is correlated with an elevated risk of adverse health outcomes, such as increased hospital admissions and higher healthcare costs.[11-14]

With the wealth of Internet-based educational resources available, a patient's online healthcare literacy is crucial in the realm of cardiovascular medicine. However, there remains a paucity of data evaluating the quality and content of the informational resources provided to patients in an online setting. The current literature on online cardiovascular disease education relatively has focused on disease education rather than diagnostic and therapeutic cardiac interventions which patients may be involved with during their disease management.[15-18] This scarcity of information can hinder our comprehension of the existing landscape of online healthcare resources and diminish the focus on enhancing these resources if they fail to adequately educate patients on the subject matter. Therefore, the aim of this study is to describe and characterize the healthcare literacy profile of online patient educational materials on diagnostic and therapeutic cardiac interventions.

METHODS

To address the primary aim of this study, we performed a cross-sectional study in April 2023 to characterize components of healthcare literacy.[19] This study did not require institutional review board approval given that it did not require human participants or animal subjects, and all the data utilized in this study were publicly available. The authors utilized a machine learning-based search engine algorithm, specifically RankBrain (Google, Mountain View, CA).[20-23] In this public machine learning application, the most frequently asked questions were queried until the first unique 20 were extracted from the following categories: cardiac catheterization, percutaneous coronary intervention, balloon angioplasty, atherectomy, intra-aortic balloon pump, transcatheter aortic valve replacement, laser angioplasty, ventricular assist device, coronary artery calcium scan, echocardiogram, electrophysiology study, electrocardiogram, cardiac pacemaker. The choice of these categories was based on findings reported in previous literature.[24-28] The first 40

Copyright © 2023 Singh, et al. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial No Derivatives (by-nc-nd) License. (CC-BY-NC-ND 4.0: https://creativecommons.org/licenses/by-nc-nd/4.0/)

questions and associated articles of each category were extracted based on these inclusion criteria: (1) the question and article are written in the English language, (2) the articles were publicly accessible without the creation of a subscription account or payment, (3) each article was at least 100 words, and (4) articles were extracted from the same search query.

After extracting each question and corresponding article, four independent reviewers evaluated each question per Rothwell's Classification of Questions as demonstrated in previous literature.[20,29-33] This classification was modeled after previous literature, as Rothwell's Classification of Questions broadly categorizes the questions into the following categories: "Fact", "Policy", or "Value".[20,21,29-33] Additionally, these three categories were further subclassified by the raters into each respective group. This included questions regarding specific activities, length of time, restrictions, technical details, or costs within the "Fact" category. Questions within the "Policy" category were further subclassified as questions regarding either indications or complications. Questions within the "Value" category were further subclassified as questions regarding the evaluation of credibility or risk/benefit appraisal.[21,29-31,33]

The corresponding educational articles, also addressed as an "educational resource" in this study, were further evaluated for content readability as shown in previous literature.[33] Specifically, the literature content of the educational article was reformatted to plain text, Times New Roman, 12-point font, on Microsoft® Word to allow raters to efficiently calculate readability scores for each resource. Additionally, resources were reformatted to remove author information, copyright disclaimers, figures, captions, legends, references, and web page navigation hyperlinks prior to the calculation of scores and standard deviation (SD) as outlined in previous literature. No content was revised or reviewed for source appraisal. Raters were then instructed to perform the following readability calculations after resource reformatting: Flesch Kincaid Grade Reading Level, Flesch Reading Ease, Gunning-Fog Index Readability, Coleman-Liau Index, Simple Measure of Gobbledygook (SMOG)Index, and Linsear Write Formula. The selection of these formulas was modeled on previous literature (Table 1).[33,34] The use of readability calculations in this methodology was to serve as a modality to determine the quality and comprehension of these patient education resources as described in the aim of this study. Moreover, the use of these calculations can determine if the patient educational resources regarding each cardiac intervention meets reading level recommendations in the U.S. Educational resources which do not meet this recommendation can be considered more complex in terms of comprehension for patients. Regarding data tabulation, raters recorded all data using Microsoft® Excel 2021 (Microsoft Corporation, Redmond, WA), and the date of the search queries also was tabulated to minimize potential ambiguity in data extraction.[34-36] Inter-rater reliability was used to determine the degree of similarity among raters when quantifying Rothwell's Classification of Questions. The use of this calculation would determine the degree of validity among the results.

RESULTS

There was a collective of 520 questions and associated articles across 13 cardiovascular interventions that were successfully extracted based on inclusion and exclusion criteria. Most articles (95.6%, n = 497) were from the U.S., followed by the United Kingdom (3.1%, n = 16). Nearly 31% (n = 161) of the articles were from academic institutions, 30.4% (n = 158) from commercial sources, 15.8% (n = 82) from government sources, 15.4% (n = 80) from medical practice, and 7.5% (n = 39) from media outlets. Table 2 contains further course classification by the cardiovascular intervention of interest. Precisely, no source classification succeeded in over 40% of each category among the 13 cardiac interventions.

Regarding the 520 frequently asked questions extracted by the raters, there was an inter-rater reliability at 96.9% among Rothwell's Classification of Questions. Most of the questions were classified as "Fact" at 76.0% (n = 395), followed by "Value" at 14.2% (n = 74), and "Policy" at 9.8% (n = 51; Table 3). Further subclassification of questions within each category demonstrated that questions regarding "Technical Details"- a subclassification of the "Fact" category - of each cardiac intervention were most common at 56.3% (n = 293), followed by the subclassification regarding "Evaluation of the Surgery" - a subclassification of the "Value" category - at 8.5% (n = 44).

Regarding readability, a total of 3,120 readability scores were calculated from the 520 articles extracted in this study using six readability formulas (Table 4). Educational resources with content regarding an electrophysiology study had the lowest Flesh-Kincaid score at 10.2 (SD = 2.4), whereas resources regarding transcatheter aortic valve replacement had the highest Flesh-Kincaid score at 12.8 (SD = 6.8). Among Flesh Reading Ease calculations, resources regarding echocardiogram had the highest readability score at 67.4 (SD = 85.3), whereas resources regarding percutaneous coronary intervention had the lowest readability score at 43.4 (SD = 16.7; Figure 1). Among Gunning-Fog calculations, the average score was highest among resources regarding intra-aortic balloon pumps at 15.1 (SD = 5.9), and the lowest average score was among resources regarding echocardiograms at 12.6 (SD = 2.0). Among Coleman-Liau Index, the average score was highest among resources regarding percutaneous coronary intervention at 11.8 (SD = 2.6), and the lowest average score was the same between resources regarding laser angioplasty at 10.7 (SD = 1.7) and regarding echocardiograms at 10.7 (SD = 1.7).

Among SMOG calculations, the average score was highest among resources regarding percutaneous coronary intervention at 10.9 (SD = 2.1) and the lowest average score was among resources regarding echocardiograms at 9.2 (SD = 1.3). Among Linsear-Write calculations, the average score was highest among resources regarding transcatheter aortic valve replacement at 13.2 (SD = 5.1) and ventricular left assist devices at 13.2 (SD = 4.4), and lowest average score was among resources regarding an electrophysiology study at 10.8 (SD = 3.0).

Table 1. Readability calculations.

Readability Calculation	Formula
Flesch Kincaid	0.39 x (words/sentences) + 11.8 x (syllables/words) – 15.59
Flesh Reading Ease	206.835 - 1.015 × (total words ÷ total sentences) - 84.6 × (total syllables ÷ total words)
Gunning Fog	0.40 [(words/sentences) + 100 (complex words/words)]
Coleman-Liau	0.0588 (average number of letters per 100 words) – 0.296 (average number of sentences per 100 words) – 15.8
Simple Measure of Gobbledygook (SMOG)	3 + √(number polysyllabic words)
Linsear Write	4.71(characters/words) = 0.5(words/sentences) – 21.43

Table 2. Source frequency of educational materials on cardiac interventions.

Cardiac Intervention	Academic Institution	Commercial	Government Website	Media Outlet	Medical Practice
Atherectomy	10	10	11	2	7
Balloon Angioplasty	10	9	8	9	4
Cardiac Catheterization	15	11	8	2	4
Cardiac Pacemakers	8	9	10	6	7
Coronary Artery Calcium Scan	13	14	3	1	9
Echocardiogram	13	13	4	1	9
Electrocardiogram	12	16	3	1	8
Electrophysiology Study	15	12	4	0	9
Intra-aortic Balloon Pump	11	10	6	7	6
Laser Angioplasty	12	12	6	4	6
Percutaneous Coronary Intervention	10	10	7	5	8
Transcatheter Aortic Valve Replacement	16	16	8	0	0
Ventricular Assist Device	16	16	4	1	3

Table 3. Frequency table of Rothwell's Classification of Questions on cardiac interventions.

Cardiac Intervention	Fact	Policy	Value
Atherectomy	26	10	4
Balloon Angioplasty	32	4	4
Cardiac Catheterization	28	3	9
Cardiac Pacemakers	34	3	3
Coronary Artery Calcium Scan	36	1	3
Echocardiogram	34	4	2
Electrocardiogram	30	4	6
Electrophysiology Study	35	5	0
Intra-aortic Balloon Pump	27	2	11
Laser Angioplasty	33	1	6
Percutaneous Coronary Intervention	30	1	9
Transcatheter Aortic Valve Replacement	23	6	11
Ventricular Assist Device	27	7	6

Table 4. Readability calculations of educational materials on cardiac interventions.

Cardiac Interventions	Flesch Kincaid Average *SD*	Flesch Reading Ease Average *SD*	Gunning-Fog Average *SD*	Coleman-Liau Index Average *SD*	SMOG Average *SD*	Linsear Write Average *SD*
Atherectomy	11.4	45.0	14.3	11.5	10.6	12.2
	3.2	*17.6*	*3.2*	*2.5*	*2.4*	*3.9*
Balloon Angioplasty	11.2	47.8	14.0	11.0	10.3	12.3
	2.5	*13.3*	*2.5*	*1.6*	*1.7*	*3.4*
Cardiac Catheterization	10.9	49.9	14.0	10.8	10.3	12.3
	2.7	*16.0*	*3.0*	*2.3*	*2.1*	*3.2*
Cardiac Pacemakers	10.4	51.8	13.4	10.9	9.9	11.4
	2.2	*12.5*	*2.4*	*2.2*	*1.7*	*2.9*
Coronary Artery Calcium Scan	11.3	47.0	14.2	10.9	10.6	12.5
	2.1	*12.3*	*2.5*	*2.2*	*1.7*	*2.9*
Echocardiogram	12.1	67.4	12.6	10.7	9.2	10.9
	2.9	*85.3*	*2.0*	*1.7*	*1.3*	*2.8*
Electrocardiogram	10.3	53.0	13.3	10.9	9.7	11.6
	3.1	*17.1*	*3.3*	*2.5*	*2.4*	*3.8*
Electrophysiology Study	10.2	51.8	13.5	10.9	9.8	10.8
	2.4	*13.8*	*3.5*	*2.0*	*1.9*	*3.0*
Intra-aortic Balloon Pump	11.5	44.0	15.1	11.3	10.7	12.4
	3.5	*19.9*	*5.9*	*2.7*	*2.6*	*4.1*
Laser Angioplasty	11.2	48.5	14.4	10.7	10.5	12.6
	3.0	*13.2*	*3.2*	*1.7*	*2.3*	*5.0*
Percutaneous Coronary Intervention	11.9	43.4	14.7	11.8	10.9	12.9
	2.8	*16.7*	*2.9*	*2.6*	*2.1*	*3.3*
Transcatheter Aortic Valve Replacement	12.8	44.3	14.6	11.1	10.7	13.2
	6.8	*16.5*	*3.5*	*2.3*	*2.4*	*5.1*
Ventricular Assist Device	11.5	50.5	14.0	10.9	10.4	13.2
	4.1	*14.4*	*3.2*	*1.6*	*2.4*	*4.4*

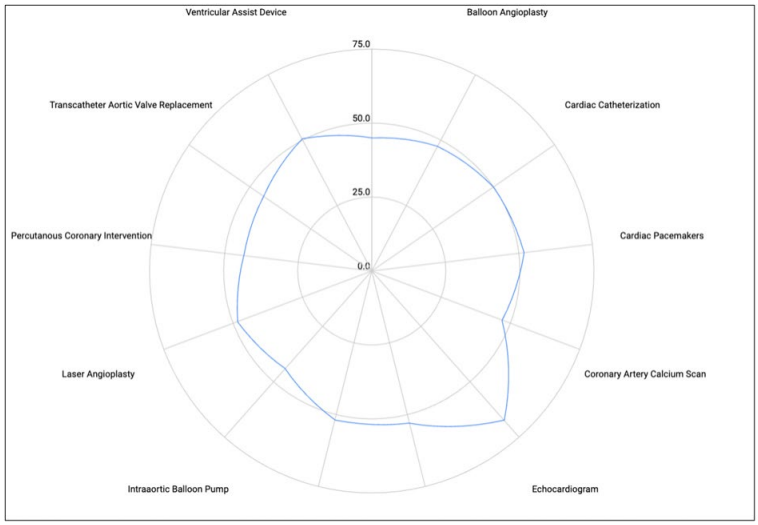

Figure 1. Illustration of Flesch Reading Ease among cardiac interventions.

DISCUSSION

The rapid evolution of internet accessibility by the public, as well as the degree of oversight on fact-verification or resource credibility, creates a continuous need to evaluate and describe the climate of online health literacy.[34-37] Similarly, information-seeking behavior among patients using these online resources, contributed by resource convenience, can play a role in the physical and mental health of a patient. Moreover, there is literature that suggests improper information-seeking behavior may be related to high-risk behaviors, including improper medication use, as well as reduced optimization in cardiovascular care.[38-40] To address this current climate, this research investigation provided a descriptive profile of publicly available online educational resources and questions regarding clinical cardiovascular interventions.

Among all patient education resources included in this study, the source origin of most articles was from the U.S. at 95.6%, followed by the United Kingdom at 3.1%. These findings enable us to establish a geographical localization within our dataset.[41] They suggest that the dataset of patient education materials used in this study would be most relevant for users seeking medical care within the U.S. healthcare infrastructure. Therefore, these findings may not be as informative for patients seeking information on these cardiac interventions in other countries, where guidelines, recommendations, and provisions may differ from those in the U.S.[42,43] For example, the difference in insurance reimbursement structure schemes may vary among patients who enquire about a specific cardiac intervention (i.e., echocardiography) in the U.S. and in a different country.[1,2,41,42] This can potentially account for a difference in the amount of applicable information, which can be relevant to the patient. Additionally, the most frequent source classification of articles was heavily composed of academic institutions at 31% and commercial sources at 30.4%. The prevalence of academic institutions in this dataset also implies a higher likelihood that the authors of each online education resource are affiliated with an academic setting rather than a privately employed practice. Additionally, educational materials from academic sources may have more interest to utilize literature using clinical research data compared to commercial sources which could rely on the potential utilization of aspects, such as physician credibility or medical brands.[43-45]

The results of Rothwell's Classification of Questions in this study may indicate that patients are leaning toward seeking information regarding cardiac interventions rather than asking questions that evaluate the policies or perspectives of cardiac interventions. This finding could indicate that there is a curiosity present among patients and that may be due to a generalized paucity of knowledge regarding these cardiac interventions, or potentially due to a lack of content that appropriately answers the questions asked by patients in the U.S. Moreover, a majority of questions were focused on the technical details regarding each procedure compared to other subclassifications in the "Fact" category. This discovery is intriguing, particularly when contemplating the vital role that questions about costs or restrictions play in a patient's education about cardiac interventions. It implies a scarcity of inquiries related to costs, indicating that patients may be directing such queries to alternative sources, such as their health insurance provider or physicians, rather than seeking information online.[20,46-48] Future research should focus on comparing quality of primarily cost-based patient education resources on cardiac interventions.

The results of this readability analysis suggest that there is a generalized paucity of online patient education materials which meet institutional recommendations that the reading level of a resource should not be greater than the sixth-to-eighth-grade reading level.[49-51] However, there are certain cardiac interventions that have readability scores that may require greater attention toward improvement.[52,53] Specifically, patient education materials regarding percutaneous coronary interventions had the lowest Flesh-Reading Ease score at 43.4, which would indicate "difficult to read". Similarly, percutaneous coronary interventions had the highest Coleman-Liau index and SMOG calculations among all cardiac interventions. This finding creates further validity to the greater need to improve the readability of materials on this intervention.[53-55] Similarly, the readability scores on coronary artery calcium channel screening suggest that there remains a need to improve these materials, as readability scores have not improved since a similar analysis performed by Rodriguez et al.[56] in 2020.

To the best of our knowledge, this is the first published study that utilizes Rothwell's Classification of Questions and readability of online patient education materials on cardiac interventions in the U.S. A key strength of this study is the plan to analyze the Google RankBrain algorithm as the search query system comprises over 90% of the market share of the internet search query. Future studies ought to implement additional query programs to further increase the generalizability of these findings. Additionally, this methodology analyzed a sample size of online patient educational materials in cardiovascular medicine compared to previous literature.

Limitations. The study has limitations. Specifically, while this study employs health literacy assessment tools that are well-established in the literature, these tools do not assess the accuracy of content information among each educational resource material.[20,21,57-60] Future studies ought to develop a measurement tool to assess for information transparency

and accuracy in online educational articles. Similarly, the subjective nature of these assessment tools does not consider the potential overlap between categories when assessing questions. Although this study had a high interrater reliability of over 95%, there remains the potential to create the need for similar studies to validate these findings.

CONCLUSIONS

Overall, the findings of this study provide clinicians a direction toward improving the health literacy of patients in cardiovascular medicine. This study utilizes a machine learning algorithm to describe and assess questions commonly posed by the public audience. The findings of this study demonstrate that patients more often seek information regarding specific knowledge of each cardiovascular intervention rather than use it for value or policy-based questions or to seek advice. However, the current body of publicly available online educational literature does not meet grade-level reading recommendations across all interventions analyzed in this study. These findings encourage the need for improving literacy comprehension regarding these contemporary educational materials. Future studies ought to investigate efficacious solutions for creating general readability which can adapt to the continuously growing use of the internet.

REFERENCES

[1] Paneth N, Joyner MJ, Casadevall A. Filling in the spaces in cardiovascular epidemiology. Epidemiology 2022; 33(1):34-36. PMID: 34799481.
[2] Birger M, Kaldjian AS, Roth GA, Moran AE, Dieleman JL, Bellows BK. Spending on cardiovascular disease and cardiovascular risk factors in the United States: 1996 to 2016. Circulation 2021; 144(4):271-282. PMID: 33926203.
[3] Pilkerton CS, Singh SS, Bias TK, Frisbee SJ. Healthcare resource availability and cardiovascular health in the USA. BMJ Open 2017; 7(12):e016758. Published 2017 Dec 14. PMID: 29247082.
[4] Ihler F, Canis M. The role of the internet for healthcare information in Otorhinolaryngology. Die Rolle des Internets für Gesundheitsinformationen in der Hals-Nasen-Ohrenheilkunde. Laryngorhinootologie 2019; 98(S 01):S290-S333. PMID: 31096302.
[5] Wald HS, Dube CE, Anthony DC. Untangling the web--The impact of internet use on health care and the physician-patient relationship. Patient Educ Couns 2007; 68(3):218-224. PMID: 17920226.
[6] Brooks BA. Using the internet for patient education. Orthop Nurs 2001; 20(5):69-77. PMID: 12025306.
[7] Iverson SA, Howard KB, Penney BK. Impact of internet use on health-related behaviors and the patient-physician relationship: A survey-based study and review. J Am Osteopath Assoc 2008; 108(12):699-711. PMID: 19075034.
[8] Williamson TM, Rouleau CR, Aggarwal SG, Arena R, Hauer T, Campbell TS. The impact of patient education on knowledge, attitudes, and cardiac rehabilitation attendance among patients with coronary artery disease. Patient Educ Couns 2021; 104(12):2969-2978. PMID: 33994262.
[9] Svavarsdóttir MH, Sigurðardóttir ÁK, Steinsbekk A. Knowledge and skills needed for patient education for individuals with coronary heart disease: The perspective of health professionals. Eur J Cardiovasc Nurs 2016; 15(1):55-63. PMID: 25208726.
[10] Liu C, Wang D, Liu C, et al. What is the meaning of health literacy? A systematic review and qualitative synthesis. Fam Med Community Health 2020; 8(2):e000351. PMID: 32414834.
[11] Baker DW, Parker RM, Williams MV, Clark WS. Health literacy and the risk of hospital admission. J Gen Intern Med 1998; 13(12):791-798. PMID: 9844076.
[12] Weiss BD, Blanchard JS, McGee DL, et al. Illiteracy among Medicaid recipients and its relationship to health care costs. J Health Care Poor Underserved 1994; 5(2):99-111. PMID: 8043732.
[13] Baker DW, Parker RM, Williams MV, Clark WS, Nurss J. The relationship of patient reading ability to self-reported health and use of health services. Am J Public Health 1997; 87(6):1027-1030. PMID: 9224190.
[14] Rasu RS, Bawa WA, Suminski R, Snella K, Warady B. Health literacy impact on national healthcare utilization and expenditure. Int J Health Policy Manag 2015; 4(11):747-755. Published 2015 Aug 17. PMID: 26673335.
[15] Ayyaswami V, Padmanabhan D, Patel M, et al. A readability analysis of online cardiovascular disease-related health education materials. Health Lit Res Pract 2019; 3(2):e74-e80. PMID: 31049489.
[16] Tretter JT, Windram J, Faulkner T, et al. Heart University: A new online educational forum in paediatric and adult congenital cardiac care. The future of virtual learning in a post-pandemic world? Cardiol Young 2020; 30(4):560-567. PMID: 32228736.
[17] Oudkerk Pool MD, Hooglugt JQ, Schijven MP, et al. Review of digitalized patient education in cardiology: A future ahead? Cardiology 2021; 146(2):263-271. PMID: 33550295.
[18] Boyde M, Tuckett A, Ty J. Teacher-as-actor: Investigating the barriers and facilitators of patient education among hospitalized patients in a cardiology clinical unit. Nurs Health Sci 2021; 23(4):871-879. PMID: 34431188.
[19] Badarudeen S, Sabharwal S. Assessing readability of patient education materials: Current role in orthopaedics. Clin Orthop Relat Res 2010; 468(10):2572-2580. PMID: 20496023.
[20] Sajjadi NB, Shepard S, Ottwell R, et al. Examining the public's most frequently asked questions regarding COVID-19 vaccines using search engine analytics in the United States: Observational study. JMIR Infodemiology 2021; 1(1):e28740. Published 2021 Aug 4. PMID: 34458683.
[21] Shen TS, Driscoll DA, Islam W, Bovonratwet P, Haas SB, Su EP. Modern internet search analytics and total joint arthroplasty: What are patients asking and reading online? J Arthroplasty 2021; 36(4):1224-1231. PMID: 33162279.
[22] Morshed T, Hayden S. Google versus PubMed: Comparison of Google and PubMed's search tools for answering clinical questions in the emergency department. Ann Emerg Med 2020; 75(3):408-415. PMID: 31623934.
[23] Briscoe S, Rogers M. An alternative screening approach for Google Search identifies an accurate and manageable number of results for a systematic review (case study). Health Info Libr J 2021. PMID: 34734655.
[24] Khan TM, Siddiqui AH. Intra-Aortic Balloon Pump. In: StatPearls. Treasure Island (FL): StatPearls Publishing; April 24, 2023. PMID: 31194390.
[25] Garg P, Walton AS. The new world of cardiac interventions: A brief review of the recent advances in non-coronary percutaneous interventions. Heart Lung Circ 2008; 17(3):186-199. PMID: 18262841.
[26] Parikh PB, Bhatt DL, Bhasin V, et al. Impact of percutaneous coronary intervention on outcomes in patients with heart failure: JACC State-of-the-Art Review. J Am Coll Cardiol 2021; 77(19):2432-2447. PMID: 33985688.
[27] Perera P, Lobo V, Williams SR, Gharahbaghian L. Cardiac echocardiography. Crit Care Clin. 2014;30(1):47-v. PMID: 24295841.
[28] Ramos LM. Cardiac diagnostic testing: What bedside nurses need to know. Crit Care Nurse 2014; 34(3):16-28. PMID: 24882826.
[29] Kanthawala S, Vermeesch A, Given B, Huh J. Answers to health questions: Internet search results versus online health community responses. J Med Internet Res 2016; 18(4):e95. Published 2016 Apr 28. PMID: 27125622.
[30] Hodakowski AJ, McCormick JR, Damodar D, et al. Rotator cuff repair: What questions are patients asking online and where are they getting their answers? Clin Shoulder Elb 2023; 26(1):25-31. PMID: 36919504.
[31] McCormick JR, Kruchten MC, Mehta N, et al. Internet search analytics for shoulder arthroplasty: What questions are patients asking? Clin Shoulder Elb 2023; 26(1):55-63. PMID: 36919508.
[32] Foster BK, Brule NR, Callahan C, Baylor J, Klena JC, Grandizio LC. Online information related to symptoms of carpal tunnel syndrome: A Google Search analysis. Cureus 2023; 15(2):e35586. PMID: 37007327.
[33] Singh SP, Qureshi FM, Borthwick KG, Singh S, Menon S, Barthel B. Comprehension profile of patient education materials in endocrine care. Kans J Med 2022; 15:247-252. PMID: 35899057.
[34] Wang LW, Miller MJ, Schmitt MR, Wen FK. Assessing readability formula differences with written health information materials: Application, results, and recommendations. Res Social Adm Pharm 2013; 9(5):503-516. PMID: 22835706.
[35] Kandula S, Zeng-Treitler Q. Creating a gold standard for the readability measurement of health texts. AMIA Annu Symp Proc 2008; 2008:353-357. PMID: 18999150.
[36] Sapci AH, Sapci HA. Artificial intelligence education and tools for medical and health informatics students: Systematic review. JMIR Med Educ 2020; 6(1):e19285. PMID: 32602844.

[37] Bennett NL, Casebeer LL, Kristofco RE, Strasser SM. Physicians' internet information-seeking behaviors. J Contin Educ Health Prof 2004; 24(1):31-38. PMID: 15069910..
[38] Rexhepi H, Huvila I, Åhlfeldt RM, Cajander Å. Cancer patients' information seeking behavior related to online electronic healthcare records. Health Informatics J 2021; 27(3):14604582211024708. PMID: 34296650.
[39] Ellis J, Mullan J, Worsley A, Pai N. The role of health literacy and social networks in arthritis patients' health information-seeking behavior: A qualitative study. Int J Family Med 2012; 2012:397039. PMID: 22997575.
[40] Ziehfreund S, Tizek L, Zink A. Websearch-Daten als Gesundheitsdaten?: Geografische Unterschiede, zeitliche Trends und Interessenschwerpunkte von Internetsuchmaschinenanfragen in Deutschland [Web search data as health data?: Geographic differences, temporal trends, and topics of interest from internet search engine analyses in Germany]. Hautarzt 2022; 73(1):53-60. German. Erratum in: Dermatologie (Heidelb) 2022; 73(9):756. PMID: 34812913.
[41] Weaver MR, Nandakumar V, Joffe J, et al. Variation in health care access and quality among US states and high-income countries with universal health insurance coverage [published correction appears in JAMA Netw Open 2021; 4(8):e2125050]. JAMA Netw Open 2021; 4(6):e2114730. PMID: 34181011.
[42] Rice T, Rosenau P, Unruh LY, Barnes AJ, Saltman RB, van Ginneken E. United States of America: Health system review. Health Syst Transit 2013; 15(3):1-431. PMID: 24025796.
[43] Cooper PS, Lipshultz D, Matten WT, et al. Education resources of the National Center for Biotechnology Information. Brief Bioinform 2010; 11(6):563-569. PMID: 20570844.
[44] Brindley PG, Byker L, Carley S, Thoma B. Assessing on-line medical education resources: A primer for acute care medical professionals and others. J Intensive Care Soc 2022; 23(3):340-344. PMID: 36033246.
[45] Van Doren DC, Blank KM. Patient education: A potential marketing tool for the private physician. J Health Care Mark 1992; 12(1):71-77. PMID: 10145615.
[46] Khalil LS, Castle JP, Akioyamen NO, et al. What are patients asking and reading online? An analysis of online patient searches for rotator cuff repair. J Shoulder Elbow Surg 2023; 32(11):2245-2255. PMID: 37263485.
[47] Sajjadi NB, Ottwell R, Shepard S, et al. Assessing the United States' most frequently asked questions about osteopathic medicine, osteopathic education, and osteopathic manipulative treatment. J Osteopath Med 2022; 122(5):219-227. PMID: 35179005.
[48] Fassas SN, Peterson AM, Farrokhian N, et al. Sinus surgery and balloon sinuplasty: What do patients want to know? Otolaryngol Head Neck Surg 2022; 167(4):777-784. PMID: 35133898.
[49] Eltorai AE, Ghanian S, Adams CA Jr, Born CT, Daniels AH. Readability of patient education materials on the american association for surgery of trauma website. Arch Trauma Res 2014; 3(2):e18161. PMID: 25147778.
[50] Badarudeen S, Sabharwal S. Assessing readability of patient education materials: Current role in orthopaedics. Clin Orthop Relat Res 2010; 468(10):2572-2580. PMID: 20496023.
[51] The US Centers for Disease Control and Prevention. April 2009. Simply Put: A guide for creating easy-to-understand materials. https://www.cdc.gov/healthliteracy/pdf/simply_put.pdf. Accessed May 1, 2023.
[52] Hameed I, Hameed NUF, Oakley CT, et al. Systematic assessment of online health information for coronary revascularization. JAMA Intern Med 2021; 181(7):1003-1006. PMID: 32228736.
[53] Higgins RO, Murphy BM, Le Grande MR, Parkinson A, Worcester MU, Goble AJ. Expressed preferences for health education of patients after percutaneous coronary intervention. Eur J Cardiovasc Prev Rehabil 2005; 12(6):572-579. PMID: 16319548.
[54] Ingle MP, Lammons W, Guigli R, et al. Patient perspectives on the benefits and risks of percutaneous coronary interventions: A qualitative study. Patient Prefer Adherence 2021; 15:721-728. PMID: 33883883.
[55] Perk J, Hambraeus K, Burell G, Carlsson R, Johansson P, Lisspers J. Study of Patient Information after percutaneous Coronary Intervention (SPICI): Should prevention programmes become more effective? Euro Intervention 2015; 10(11):e1-7. PMID: 24472705.
[56] Rodriguez F, Ngo S, Baird G, Balla S, Miles R, Garg M. Readability of online patient educational materials for coronary artery calcium scans and implications for health disparities. J Am Heart Assoc 2020; 9(18):e017372. PMID: 32865121.
[57] Misra P, Agarwal N, Kasabwala K, Hansberry DR, Setzen M, Eloy JA. Readability analysis of healthcare-oriented education resources from the American Academy of Facial Plastic and Reconstructive Surgery. Laryngoscope 2013; 123(1):90-96. PMID: 23023924.
[58] Kher A, Johnson S, Griffith R. Readability assessment of online patient education material on congestive heart failure. Adv Prev Med 2017; 2017:9780317. PMID: 28656111.
[59] Hansberry DR, Agarwal N, Baker SR. Health literacy and online educational resources: An opportunity to educate patients. AJR Am J Roentgenol 2015; 204(1):111-116. PMID: 25539245.
[60] Misra P, Kasabwala K, Agarwal N, Eloy JA, Liu JK. Readability analysis of internet-based patient information regarding skull base tumors. J Neurooncol 2012; 109(3):573-580. PMID: 22810759.

Keywords: health literacy, patient education, cardiology, cardiac intervention, readability