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ORIGINAL ARTICLE

The Quality of Online Resources Available to Patients Interested in Knee Biologic Therapies Is Poor

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Abstract *Background:* As the use of biologic therapies for the management of knee pathology continues to expand, it is more likely that patients will turn to the Internet to gather information on this topic. Given the lack of scientific consensus on the use of biologics, care providers must understand what information is available online. *Questions/Purposes:* The purpose of this study was to evaluate the quality of websites that patients may use to educate themselves on knee biologics. *Methods:* Websites were identified using search terms relevant to multiple biologic therapies available for knee pathology. Websites were scored based on an author-derived grading rubric, with a total of 25 possible points relating to the role of knee biologics in the diagnosis, evaluation, and treatment of knee pathology. Websites were categorized based on the source (e.g., physician-operated website vs. industry-related website). Reading level was assessed with the Flesch-Kincaid readability test. *Results:* The initial search yielded 375 results, with 96 websites meeting final inclusion criteria. Mean website score was poor, at 6.01 of the 25 possible points (24.0%). Physician websites were the most common, with 60% of the articles identified. Industry-related websites scored the lowest (mean, 3.2 ± 0.97) while hospital-related websites scored the highest (mean, 8.3 ± 2.93). Overall, websites published from hospitals or orthopedic professional societies had significantly higher scores than other websites. The search term "knee PRP" yielded higher-quality results than "knee platelet rich plasma." Similarly, "knee BMAC" led to better results than "knee bone marrow aspirate concentrate." The average reading level was 11.4. *Conclusion:* Many online resources are available for patients seeking information about knee biologic therapies, but the quality of websites identified was very poor. Patients should be counseled that the information available online for knee biologic therapy is unreliable. Surgeons should play an increased role in providing resources to patients and educating them on biologic options.

Keywords biologics · knee · PRP · platelet-rich plasma · online resources

Introduction

Biologic therapies, consisting of stem cells, platelet-rich plasma (PRP), and bone marrow aspirate concentrate (BMAC), have been applied to the treatment of a variety of musculoskeletal pathologies. Their clinical applications range from soft-tissue injuries, cartilage restoration, bone healing, and tendinopathies [1, 10, 14]. There has been increasing focus on regenerative medicine as a means of treating a variety of knee pathologies through improving the properties of healing tissue or restoring native tissue, although it still remains unclear whether these provide tangible benefits [8, 9].

The Food and Drug Administration (FDA) proposed regulations for investigation of tissue-based products in 1997 (Code of Federal Regulations, Title 21, Part 1271). Since that time, there has been increased scientific output on the use of biologic therapies. Despite increased publications in the medical literature, however, there has been a lack of uniform reporting and often few scientific details that are critical to evaluating outcomes [11]. A recent study established expert opinion on what the minimum reporting requirements should be for clinical studies evaluating

This investigation was performed at the Hospital for Special Surgery.

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biologics [11]. To date, there has been little consensus or specific recommendations on when biologics are appropriate to use or what doses provide the highest efficacy. While biologic therapy has shown great promise, more strenuous standards and objective studies must be performed before widespread clinical use can be justified [9, 11].

Given the lack of formal medical guidelines, patients may rely on online resources for information on biologics as treatments for knee disorders. As the scientific community develops in its understanding of biologic therapies, so must it understand what information is available online for patients. The purpose of this study was to evaluate and grade the quality of online resources pertaining to biologic therapies for the knee. Our hypothesis was that there would be poor-quality information available on the diagnosis, evaluation, and treatment of knee pathology with biologic therapies.

Methods

In August 2017, three separate search engines (Google, Yahoo, Bing) were used to find online resources on the use of biologics in the knee. We used search terms that patients may use on the Internet to find information about biologic therapies: the term "knee" combined with "bone marrow aspirate concentrate," "BMAC," "platelet rich plasma," "PRP," or "stem cell." This yielded five different search terms per search engine for 15 total searches. The first 25 results were recorded from each search. Websites marked as advertisements that had paid to be populated at the top of searches were excluded. Duplicate entries were removed if they appeared on multiple search engines. Websites were excluded if they were intended for medical professionals, were video content only, provided no clinical information, had no relevance to knee biologics, or the link was nonfunctional (Fig. 1).

The websites were further divided into six types: physician website, hospital website, medical device or sales industry website, professional organization website, news article, or other. Websites were evaluated for their readability based on the Flesch-Kincaid (FK) method, which assigns a grade level to denote the highest level of educationa reader must have to comprehend the text. Microsoft Word (Microsoft, Redmond, WA, USA) was used to measure the FK level.

We developed a scoring system based on a comprehensive literature review of biologic therapies and their role in knee pathology (Table 1). Our rationale for developing a scoring system was to better understand and grade how the available online resources communicate components of diagnosis, evaluation, and treatment of knee pathology requiring biologic therapy. The scoring system was modified from a prior non-validated scoring system utilized by Ghodasra et al. to evaluate online resources for platelet-rich plasma [6]. The scoring system had a maximum score of 25 points, and the senior authors, who have significant experience with knee biologic therapies, agreed upon components of the scoring system: 8 points were attributed to the diagnosis and evaluation of knee injuries, 17 to the treatment of knee pathology. We sought to develop a comprehensive grading system that captured all possible treatment options, since there was no clear consensus on optimal treatment. Two authors (CAK, CN) independently scored included websites, awarding 1 point for each criterion included. The grades were averaged between the independent reviewers to obtain a final score.

Comparative statistics were utilized to evaluate final scores and FK reading level. All comparisons were performed with t test for continuous variables and χ-squared testing for categorical variables. Statistical significance was set using a p value of less than 0.05. Analyses were performed with Stata statistical software (Version 14.2, StataCorp, College Station, TX, USA).

Results

The initial search yielded 375 websites. After removing duplicates ($n = 197$) and websites that met exclusion criteria ($n = 82$), the final group consisted of 96 websites that discussed biologics and the knee.

Mean website score was 6.01 (SD ± 2.78) of the 25 possible points (24%). Eight possible points were assigned to a discussion of diagnosis and evaluation, and the mean score for this section was 1.57 (SD ± 1.27) (19.7%). With regard to discussion of treatment, websites scored an average of 4.43 (SD ± 2.12) out of 17 possible points (26.1%). The mean reading level was 11.4 (Table 2).

We also analyzed the website scores based on type (Table 3). Physician websites which included individual surgeons or surgeon groups made up 60% of the articles meeting inclusion criteria. News articles represented 13.7% of the websites, followed by professional organizations (e.g., American Association of Orthopaedic Surgeons) at 9.5%; industry- and hospital-related websites represented 5.3% each of the websites evaluated. Hospital-related websites had the highest score at 8.30 (SD ± 2.93) points, followed by professional organization websites at 7.67 (SD ± 2.51) points. Industry- or device-related websites scored the lowest and had an average of 3.20 (SD ± 0.97) out of 25 points, which was significantly lower ($p = 0.020$) than all other combined website types. Physician websites, including surgeon or surgeon groups, scored an average of 5.72 (SD ± 2.30) of 25 points, which was lower than hospital websites ($p = 0.022$) and professional organizations ($p = 0.047$) but higher than industry websites ($p = 0.019$). Interestingly, the three highest-scoring websites were an industry website (18.5/25 points), a hospital website (13.0/25 points), and a physician website (11.0/25).

Websites retrieved using the search term "knee PRP" had an average score of 6.85 (SD ± 3.14), which was a higher score ($p = 0.034$) than for sites retrieved when the search term was spelled out as "platelet rich plasma," which scored 5.71 (SD ± 2.02). "Knee PRP" websites also scored higher than "knee bone marrow aspirate concentrate" (4.22 ± 2.34) and "knee stem cell" (4.73 ± 2.09) ($p < 0.001$ and $p = 0.002$, respectively). Similarly, "knee BMAC" scored 6.47 (SD ±

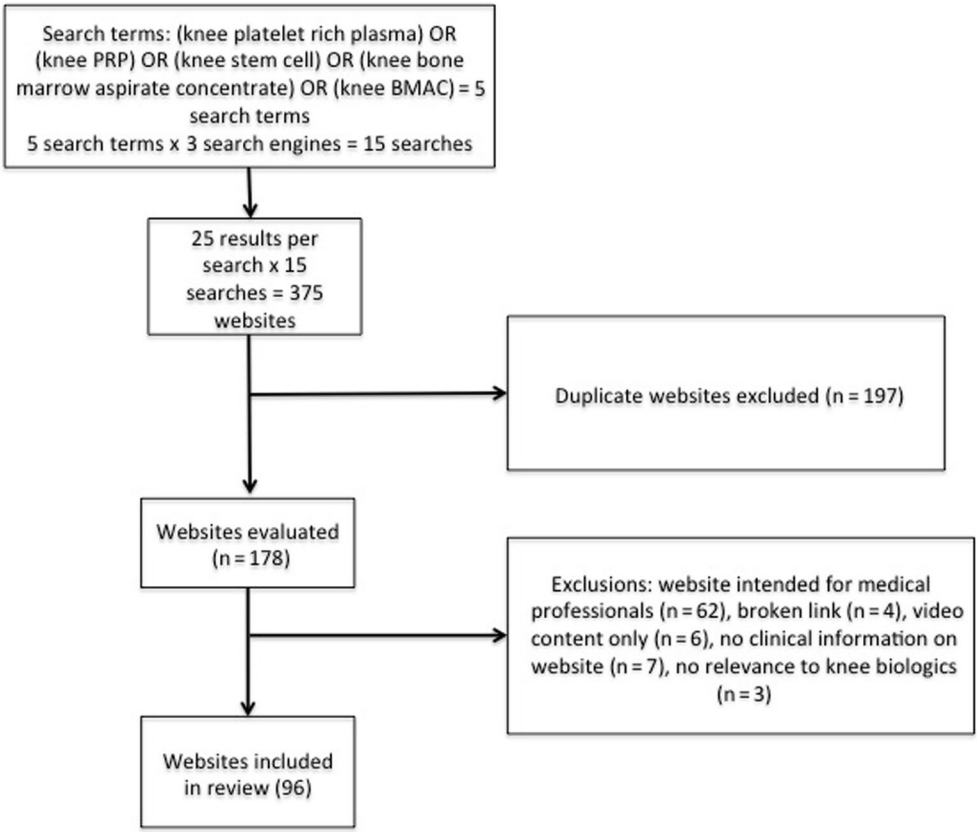

Fig. 1. Flow chart illustration of study inclusion/exclusion

Table 1 Scoring system for website information on knee biologics

Diagnosis and evaluation (8 points)
Describes in any detail the anatomy of the knee: meniscus, ligaments, cartilage
Describes in any detail the function of knee structures
Describes in any detail the process for degenerative knee disease, knee bursitis, or tendinopathy
Knee conditions and diagnoses that biologics can be used for
Physician may examine your knee
Physician may obtain knee radiographs
Physician may obtain MRI to evaluate cartilage and knee structures
Appropriate patient selection (older patients and severe arthritis not as appropriate)
Treatment (17 points)
Conservative treatment methods including rest and activity modification
Role of physical therapy is discussed
Weight loss
Role of bracing is discussed
Role of anti-inflammatories and analgesics
Non-biologic injections (corticosteroid and viscosupplement)
Alternative treatments (acupuncture, glucosamine, topical cream, and capsaicin)
Presents more than 1 biologic option
Discusses medical literature on the efficacy of treatments
Acknowledges that treatment is considered controversial or that evidence base is limited
Discusses the process for obtaining/harvesting/retrieving biologic agent
Discusses mechanism of action of biologics
Discusses the role of insurance coverage and out of pocket expenses
Surgery can be used to address advanced cartilage loss (cartilage procedure or joint replacement)
Biologics can be given as augments to knee cartilage or ligament reconstructive surgeries
Discusses any necessary rehabilitation after biologic treatment (e.g., weight-bearing status)
Mentions any applicable side effect or risk
Total_____/25pts

MRI magnetic resonance imaging

Table 2 Mean category scores for included studies

	Mean score	Standard deviation	% score
Diagnosis and evaluation	1.57/8	1.27	19.7
Describes in any detail the anatomy of the knee: meniscus, ligaments, cartilage	0.18	0.32	18.2
Describes in any detail function of knee structures	0.12	0.29	12.0
Describes in any detail the process for degenerative knee disease, knee bursitis or tendinopathy	0.23	0.38	22.9
Knee conditions and diagnoses that biologics can be used for	0.70	0.34	70.3
Physician may examine your knee	0.04	0.16	4.2
Physician may obtain knee radiographs	0.06	0.22	5.7
Physician may obtain MRI to evaluate cartilage and knee structures	0.06	0.22	6.3
Appropriate patient selection (older patients and severe arthritis not as appropriate)	0.18	0.32	17.7
Treatment	4.43/17	2.12	26.1
Conservative treatment methods including rest and activity modification	0.10	0.26	9.9
Role of physical therapy is discussed	0.14	0.29	13.5
Weight loss	0.06	0.22	5.7
Role of bracing is discussed	0.04	0.20	4.2
Role of anti-inflammatories and analgesics	0.10	0.25	10.4
Non-biologic injections (corticosteroid and viscosupplement)	0.28	0.41	28.1
Alternative treatments (acupuncture, glucosamine, topical cream, and capsaicin)	0.03	0.14	3.1
Presents more than 1 biologic option	0.26	0.36	26.0
Discusses medical literature on the efficacy of treatments	0.58	0.45	57.8
Acknowledges that treatment is considered controversial or that evidence base is limited	0.39	0.44	38.5
Discusses the process for obtain/harvesting/retrieving biologic agent	0.65	0.42	64.6
Discusses mechanism of action of biologics	0.54	0.36	53.6
Discusses the role of insurance coverage and out of pocket expenses	0.34	0.46	33.9
Surgery can be used to address advanced cartilage loss (cartilage procedure or joint replacement)	0.21	0.32	21.4
Biologics can be given as augments to knee cartilage or ligament reconstructive surgeries	0.11	0.26	10.9
Discusses any necessary rehabilitation after biologic treatment (e.g., weight-bearing status)	0.27	0.36	26.6
Mentions any applicable side effect or risk	0.35	0.40	34.9
Total score	6.01/25	2.78	24.0

MRI magnetic resonance imaging

2.61), which was higher than "knee bone marrow aspirate concentrate" ($p < 0.001$). "Knee BMAC" also scored higher than "knee stem cell" ($p = 0.004$). There was no difference in scores between search engines ($p > 0.05$ for all comparisons).

Discussion

Patients have increasingly sought health-related information online. Physicians can improve their relationship with patients by understanding what background information a patient may have coming in to an encounter. Increasingly, authors are reporting that the quality and accuracy of websites patients may use to obtain information related to their health can be inadequate [2, 4, 5, 7, 12]. Biologic therapies and their use in the knee are an area of vast research and interest within the medical field. Understanding the information available online pertaining to biologics and the knee will allow the physician to tailor conversations with patients to areas where there is a lack of information available online or address commonly found inaccuracies from the Internet.

This study has several limitations. Our results are only as generalizable as the search terms we used. We attempted to control for this by including full and abbreviated terms (i.e., *platelet rich plasma* and *PRP*), but there are other ways patients may search for this information. The top 25 websites for each search term were included, and there is the possibility that we excluded potentially informative or high-quality resources. Prior studies support that patients are more likely to modify their search term than turn to the second page of results for a particular search [3]. Additionally, our study may have been limited by our scoring system. We used a scoring system developed from a comprehensive literature review on biologic therapies and their use in the knee; as such, it was not validated. Since the literature on knee biologics is evolving, our scoring system was weighted toward rewarding websites with comprehensive and balanced information.

The available online resources on knee biologic therapies were limited, an average score of 6.01 (SD ± 2.78) out of a possible 25 points (24%). The quality of the sites was surprisingly low and emphasizes that healthcare providers should inform their patients about the diagnosis and evaluation of knee pathology and provide information on treatment options, including biologics. The use of biologic therapies is expected to increase significantly in the coming years [9]. There are currently 61 clinical trials ongoing for PRP use in the knee, eight clinical trials for BMAC use in the knee, and 81 clinical trials for stem cells use in the knee (https://clinicaltrials.gov). As our knowledge advances on the use of biologic therapies in knee pathology, the content on such websites should become more comprehensive.

We believe that a well-structured website designed to educate patients on knee biologics should not only be set at an appropriate reading level but should also contain most items in Table 1. Ideally, patient-education websites should

Table 3 Mean scores based on website creator

Article type	Total score (Avg.)	SD	Percent of total points	Total number of articles (*N*)	Percent of articles	Total score of other types (Avg.)	SD	*p* value (vs. all other articles)
1. Physician (including individual surgeon or surgeon group)	5.72	2.30	22.9	57	60.0	6.42	3.36	0.225
2. Hospital	8.30	2.93	33.2	5	5.3	5.88	2.73	0.058
3. Medical device or sales industry	3.20	0.97	12.8	5	5.3	6.16	2.77	0.020
4. Professional organization (e.g., AAOS)	7.67	4.54	30.7	9	9.5	5.83	2.51	0.059
5. News articles	5.88	2.97	23.5	13	13.7	6.02	2.77	0.868
6. Other	6.92	2.44	27.7	6	6.3	5.94	2.80	0.410

AAOS American Association of Orthopaedic Surgeons

serve several purposes: (1) preparing patients for physician visits by explaining what to expect (i.e., required diagnostic studies and possible examination maneuvers), (2) explaining the disease process, (3) discussing possible treatment options, and (4) presenting a balanced assessment of the current evidence. By doing so, these websites could serve as a resource both before and after the physician encounter.

Only 4 out of the 25 points appeared in the majority of the websites; these included knee conditions and diagnoses that biologics may be used for; the process for obtaining, harvesting, or retrieving the biologic agent; discussing the medical literature on efficacy; and discussing biologics' mechanism of action (70.3, 64.6, 57.8, and 53.6%, respectively). The vast majority of websites discussed the medical literature on the efficacy of biologics, but only 38% acknowledged that treatment is considered controversial or that evidence supporting their use is limited. Furthermore, only 17.7% of the websites mentioned appropriate patient selection criteria. In addition to our finding of low-quality information on knee biologics, we found that the websites were published at an inappropriately high reading level. Included websites contained text comprehensible at an average grade level of 11.4. Prior studies have shown that a reading level above sixth grade decreases patient understanding [13], which may further contribute to misunderstanding the role of biologics in knee pathology.

We also analyzed the quality of websites based on their authors. A majority of sites were physician related (60%). Interestingly, industry websites scored significantly lower than physician ($p = 0.019$), hospital ($p = 0.006$), and other ($p = 0.011$) sites and demonstrated a trend toward being significantly lower than professional organization ($p = 0.054$) and news-related ($p = 0.069$) sites. Understanding that industry-related websites may have lower-quality information can be helpful for patients, and there may be benefit to critically evaluating knee biologic information provided on industry-related sites. Interestingly, hospital-related websites provided the highest-quality information, even more so than professional organization and provider-derived websites. Websites from physicians or physician professional organizations are most likely to be viewed as reliable, and it may be helpful for patients to understand that hospital-based websites provide the highest-quality information.

This study provides a comprehensive analysis of available online resources on knee biologics. While previous studies have examined available online resources on PRP [6], we examined a more expansive array of websites by including BMAC and stem cells in addition to PRP. We also examined websites based on the type of source, which provided insight into the varying quality of websites available to patients based on who is publishing them. This allows us to conclude where patients access information and which types they find most valuable.

A number of online resources are available for patients seeking information about knee biologics. The quality of sites we identified was very poor. Those related to hospitals and professional orthopedic societies appear to provide better information, while websites related to industry provide the lowest. Patients should be counseled that

information available online for knee biologics is unreliable. Surgeons should play an increased role in providing resources to patients and educating them on biologics as a therapeutic option.

Compliance with Ethical Standards

Conflict of Interest: Benedict U. Nwachukwu, MD, MBA, Ryan C. Rauck, MD, Cynthia A. Kahlenberg, MD, Chukwuma Nwachukwu, BS, William W. Schairer, MD, Riley J. Williams III, MD, David W. Altchek, MD, and Answorth A. Allen, MD, declare that they have no conflicts of interest.

Human/Animal Rights: N/A

Informed Consent: N/A

Required Author Forms Disclosure forms provided by the authors are available with the online version of this article.

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