

Twitter Mentions and Academic Citations in the Urologic Literature



Solomon Hayon, Hemantkumar Tripathi, Ian M. Stormont, Meagan M. Dunne, Michael J. Naslund, and Mohummad M. Siddiqui

OBJECTIVE	To quantify the relationship between the number of Twitter mentions and the number of academic citations a urologic publication receives.
MATERIALS AND METHODS	Two hundred and thirteen papers from 7 prominent urologic journals were examined 37 months after publication. Articles were evaluated with 2 citation based “bibliometrics” (Scopus, Google Scholar) and Twitter mentions were tracked using the Altmetric Bookmarklet. The number of article citations and Twitter mentions were compared using one-way Analysis of variance (ANOVA) and bivariate fit analysis.
RESULTS	Seventy-three percent of articles had at least 1 Twitter mention. Forty-two percent of Twitter mentions occurred within the first week of the online publication date. Articles mentioned on Twitter had 2.0-fold more Scopus citations ($P < .01$), and 2.3-fold more Google Scholar citations ($P < .01$) compared to articles with no Twitter mentions. Female urologic articles had the greatest number of Twitter mentions (5.7 mentions/article) while pediatric urology had the fewest mean number of Twitter mentions (0.8 mentions/article). A total of 8.9% of papers were tweeted by their authors. Author tweeted articles were associated with a 12.3 (2.0-fold) and 15.5 (1.8-fold) mean citation increase for Scopus and Google Scholar ($P < .01$ and $P = .01$) compared to articles not shared by their authors on Twitter.
CONCLUSION	The majority of urologic publications are being shared on Twitter. The number of citations a urologic publication receives up to 3 years after release is positively associated with the number of mentions it has on Twitter. Twitter activity may be an early indicator of ultimate academic impact of an academic urologic paper. UROLOGY 123: 28–33, 2019. © 2018 Elsevier Inc.

Social media has influenced how information is shared in the academic medical community.^{1,2} In recent years, academic urology and Twitter in particular have become more intertwined, as evidenced by the 20,530 Tweets from 3591 individuals at the 2017 American Urological Association annual meeting, increased 47% from 2015.³ Twitter has become an active arena for urologists to share the latest research and interact on the merits and shortcomings of that research.^{4,5} Such activity in the social media space has called into question if there is a measurable relationship between academic urology and Twitter.

One area where academics and social media are intimately connected is in the publishing and sharing of academic manuscripts. Traditionally speaking, the scholarly impact of a paper was measured using citation based bibliometrics; that is the more peer citations a paper receives, the greater impact or merit the article must have. However,

due to the rise of social media and web-based information sharing, the broader social and scientific impact of a paper has become of greater importance.^{6,7} Alternative metrics have been developed to quantify this type of impact, as they account for distribution of a manuscript across multiple platforms. Alternative metrics have been proven to be associated with bibliometric indices with varying degrees of association in a variety of academic fields.^{8,9}

Article impact metrics are significant because institutions are beginning to use them in evaluation of faculty for promotion or tenure.¹⁰⁻¹³ Given this trend it is important to determine how traditional metrics are affected by social media use. This evaluation should be medical specialty specific, as different specialties have adopted new information sharing techniques at different rates.¹⁴ Thus, we sought to quantify the effect of Twitter mentions on the number of citations a paper receives in the urologic academic literature.

From the University of Maryland School of Medicine, Baltimore, MD; and the Division of Urology, University of Maryland Medical Center, Baltimore, MD

Address correspondence to: Mohummad M. Siddiqui, Division of Urology, University of Maryland Medical Center, 29 S. Greene Street, #500, Baltimore, MD 21201. E-mail: solhayon@gmail.com

<https://twitter.com/SolomonHayon>; <https://twitter.com/MMSiddiquiMD>

Submitted: May 22, 2018, accepted (with revisions): August 6, 2018

MATERIALS AND METHODS

Study Population

We retrospectively reviewed 213 original research articles from 7 prominent urology journals. Journals included *European Urology*,

Journal of Urology, British Journal of Urology International, Prostate Cancer and Prostatic Disease, Journal of Sexual Medicine, Journal of Endourology, and Urology.

All articles were from the January 2015 print publication of their respective journals, with the exception of articles from PCPD, which were published in December 2014. Only original research articles were included in the analysis. Editorials, reviews, opposing views, and urologic surveys were excluded.

Data Collection

Data collection was performed in February 2018, 37 months after print publication. This lag was chosen to allow the published articles to be cited in the arising literature. Two bibliometric indicators were used to determine the number of citations each article received in the academic literature. Individual article titles were entered into the search bar using the Scopus (<https://www.scopus.com/>) and Google Scholar (<https://scholar.google.com/>) websites. The resulting query provided a “cited by” number, and this value was taken to be the number of current citations the article had received. To collect data on Twitter mentions we visited the PubMed webpage for each article, then used the freely available “Altmetric Bookmarklet” (<https://www.altmetric.com/products/free-tools/bookmarklet/>) to obtain an accounting of where and when the article was mentioned on social media. Specifically, the Bookmarklet provided a full listing of individual Twitter mentions for each article. Tweet date, content, and author Twitter handle were available. Twitter profiles were cross referenced with the list of authors for each article and concurrently appearing names were tracked in our database. “Author tweeted” articles were deemed to be articles where any listed author tweeted about the paper.

Data Analysis

Statistical analysis was performed using JMP software (SAS, Cary NC). One-way ANOVA analysis was used to compare the presence or absence of Twitter mentions and the number Scopus and Google Scholar citations. One-way ANOVA analysis was used to compare the presence or absence of author tweets and the number of Scopus and Google Scholar citations. Significance for all statistical measurements was a 2-sided *P* value of $< .05$.

RESULTS

Table 1 shows the source location, average citations, and average tweets of the 213 journal articles included in the review. In terms of bibliometric measurements, the mean Google Scholar score (20.6) exceeded the mean Scopus score (13.4). A majority of articles (73%) had at least 1 mention on Twitter, with a mean of 4.4 Twitter mentions per article that received any tweets at all.

Upon examination of the timing of Twitter activity, we found that 74% of Twitter activity occurred before print publication date when publications were released online. Specifically the highest volume of tweets (42%) occurred within the first week of electronic publication date. Virtually all Twitter activity ceased within 1 year of print publication. Figure 1 shows a detailed breakdown of the Twitter mention timeline.

On univariate analysis, publications with at least 1 Twitter mention were significantly associated with increased Scopus (2.0-fold increase, $P < .01$) and Google Scholar (2.3-fold increase, $P < .01$) citations (Table 2).

Table 2 also shows the association between the authors tweeting their own paper and the number of citations the paper received. For publications where an author tweeted their own article (8.9%), univariate analysis again showed a significant associated increase in Scopus (2.0-fold increase, $P < .01$) and Google Scholar (1.8-fold increase, $P = .01$) citations compared to the articles where authors did not tweet their article. There was a 12.3 and 15.5 mean citation increase in Scopus and Google Scholar citations for author-tweeted articles.

We examined Twitter activity by subspecialty dividing journals into oncology, pediatrics, reconstruction, sexual and reproductive medicine, female, general, and endourology. Table 3 demonstrates mean Twitter activity for each specialty with the greatest activity noted in female urology and sexual and reproductive medicine (5.7 and 4.3 tweets/article). The least active specialties noted were pediatrics and reconstruction (0.8 and 1.2 tweets/article).

Of note, academic institutions rarely tweeted about their employee’s publications, with only 6/213 (2.8%) of articles having institutional Twitter mentions. Journals tweeted more commonly about articles with 61/213 (29%) articles having a journal Twitter mention. While examining the timing of each tweet in relation to electronic and print publication date we found that nearly 3/4 of all Twitter activity occurs in the time between electronic and print publication (Fig. 1). Of the tweets that occurred between electronic and print publication date, time period, 42% were within the first week of publication.

DISCUSSION

Academic urology has been using Twitter as a professional means to disseminate ideas and information.¹⁵ Calopedos

Table 1. Cumulative and journal specific mean Scopus citations, Google Scholar citations, and Twitter mentions per article

Journal Name	Number of Articles	Average Scopus Score	Average Google Score	Average Tweets
British Journal of Urology International (BJUI)	22	14.7	20.6	3.0
Endourology	18	5.3	9.3	1.5
European Urology	32	27.1	41.6	8.2
Journal of Sexual Medicine (JSM)	30	9.2	16.9	4.3
Journal of Urology	48	16.9	22.8	3.1
Prostate Cancer and Prostatic Diseases (PCPD)	11	9.5	15.0	0.9
Urology	52	7.4	12.8	0.8
Average	30	13.4	20.6	3.2

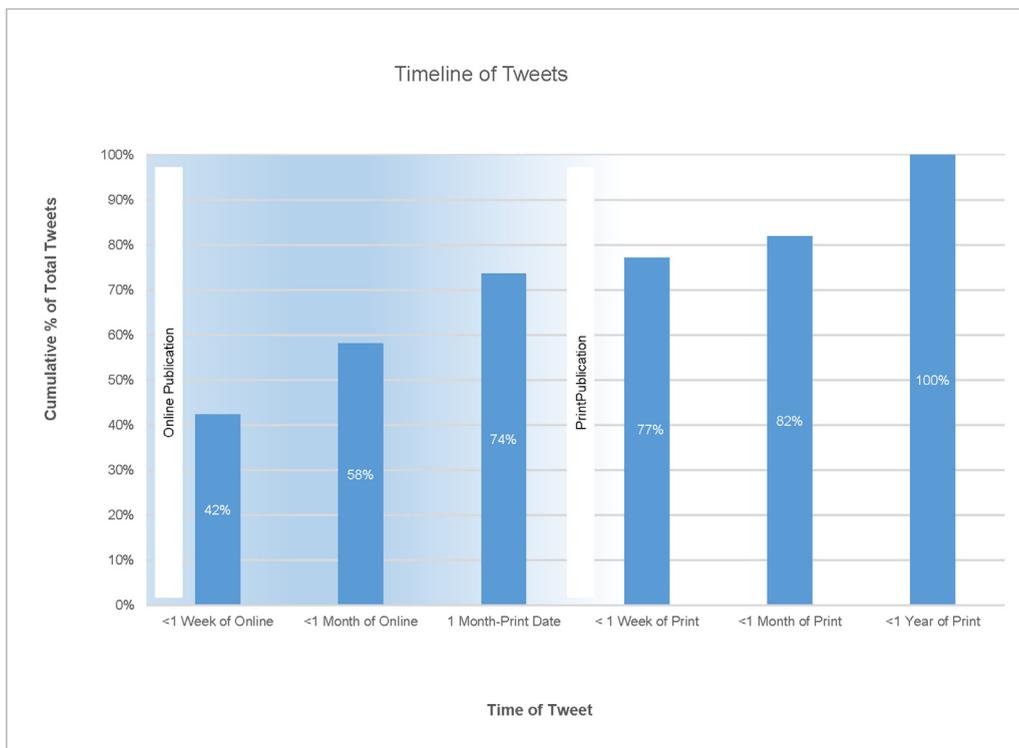


Figure 1. Timeline of Twitter mentions in relation to electronic and print publication dates. (Color version available online.)

et al demonstrated that urologic journal articles about social media were of high interest with high citation rates both in the urologic and nonurologic literature.¹⁶ Print journals are still a mainstay of information sharing for academics, but sharing published articles on Twitter allows for quicker distribution to a broader and more engaged audience who can provide real-time feedback and questions. Despite the 2 vastly different timelines of Twitter and journal publication we hypothesize there may be an association between how often an article is shared on Twitter and how often that article is cited in print. The

implication of our data is that Twitter has become a valid way to either reflect general interest or possibly even generate discussions concerning peer-reviewed material, and that the frequency of these discussions or tweets may help predict the overall impact of an academic paper.

The apparent connection between immediate Twitter mentions and delayed academic citations has been previously studied in other fields. In his 2011 article in the *Journal of Medical Internet Research*, Eysenbach used a similar method of comparing total Twitter mentions vs academic citations, and found that “highly tweeted articles were

Table 2. Average Scopus and Goggle Scholar citations based on presence of Twitter mention and author self-tweets

Metric	Not Tweeted (n = 58)	Tweeted (n = 155)	P Value	No Author Tweet (n = 194)	Author Tweet (n = 19)	P Value
Scopus	6.8	15.9	< .01	12.4	24.7	< .01
Google	12.1	23.7	< .01	19.2	34.8	.01

Table 3. Bibliometrics and Twitter activity by urologic specialty

Subspecialty	Number of Articles	Scopus Score	Google Score	Tweets	% Articles With any Tweets
Endourology	33	9.1	19.3	1.9	61%
Female	6	15.7	28.3	5.7	67%
General	21	11.5	16.9	2.7	67%
Oncology	88	13.2	20.7	3.1	64%
Pediatrics	18	6.3	9.4	0.8	50%
Reconstruction	12	5.8	9.4	1.2	58%
Sexual/Reproductive	35	7.9	14.7	4.3	83%
Total	213	13.4	20.6	3.2	73%

11 times more likely to be highly cited than less-tweeted articles.” This article was focused on 1 specific journal over a period of 3 years, whereas this article focuses on a specific field (urology), spread across a variety of journals. To the authors knowledge this would be the first specific analysis of the association between Twitter and bibliometric outcomes in the urologic literature.^{17,18} Altmetric software provided data on other forms of social media (Facebook, blogs, and news outlets), but Twitter activity was used for analysis as it was the primary modality for sharing urology articles on social media.

We examined both the bibliometric citations and Twitter mentions for articles in the urologic literature. Our emphasis was to provide a quantitative comparison between academic citations and Twitter mentions to decide if an association was present between the 2. We further characterized all tweets, breaking them down into author and non-author mentions for a given article, as well as oncologic and nononcologic based topics. Through a univariate analysis we saw that increased Twitter mentions is associated with increased citations. It is important to note that association does not imply causation here, and while author self-tweeting may have influenced visibility and ultimate citations, other explanations such as authors tweeting their best work that was ultimately destined to be highly cited are also feasible.

We examined the timecourse of Twitter activity and noted that a large proportion of Twitter activity (42%) occurred in the first week of online publication before even print publication. This may indicate a certain amount of social media momentum when the article is first printed corresponds to ultimate impact the article will show in future literature. Furthermore, use of social media to rapidly disseminate new findings may allow potential collaborators to respond quickly and directly thus accelerating the pace of research. This is of growing importance considering that more hospital systems; eg Mayo Clinic, are using social media as part of faculty evaluation metrics for academic advancement.

We acknowledge that many confounders exist in studying social media and citation patterns. Constantly changing numbers of Twitter followers and Twitter account usage, inability to track if a follower actually reads a tweet, and the presence of nonpublic tweets are all reasonable factors to consider, but can be exceedingly difficult to control for. As such our analysis is univariate, and conducted with the knowledge that our outcomes may point to a general trend in urology, and that the specific quantitative results representing only a snapshot in time. Causality is difficult to determine as well. While social media activity was associated with citations, it remains unclear if social media visibility led to ultimately greater citations, or factors that lead to greater citations also led to greater social media activity.

Follow-up studies could examine if the amount of “followers” individual Twitter accounts have leads to a more-or less-exaggerated associations of our findings. For

example, the official Twitter account of academic journals almost universally have more followers than an individual authors account, and a single Twitter mention from the journal may have more of an impact than multiple mentions from a group of authors with a limited audience. Along the same lines, an author with a high follower rate may be able to promote articles much more effectively, and it would be interesting to quantify the degree of influence an individual account may have.

CONCLUSION

We analyzed the association between Twitter activity and academic citations. Overall, articles mentioned on Twitter were shown to have a 2.0-fold and 2.3-fold citation increase for Scopus and Google Scholar compared to articles not on Twitter. Twitter activity after journal publication may be an early indicator of ultimate academic impact factor of a urologic academic paper.

Acknowledgments. Twitter reference tracking was made possible by Altmetric Software, available at: <https://www.altmetric.com/audience/researchers/>

References

1. Roupret M, Misrai V. Exponential use of social media in medicine: example of the interest of Twitter in urology. *Progres en Urologie*. 2015;25:11–17.
2. Adie E, Roe W. Altmetric: enriching scholarly content with article-level discussion and metrics. *Learned Publishing*. 2013;26:11–17.
3. Hartigan S. Now trending: Twitter use in the urology community at the American Urological Association annual scientific meeting. *J Urol*. 2016;195:e502.
4. Borgmann H, DeWitt S, Tsaor I, Haferkamp A, Loeb S. Novel survey disseminated through Twitter supports its utility for networking, disseminating research, advocacy, clinical practice, and other professional goals. *Can Urol Assoc J*. 2015;9:E713–E717.
5. Matta R, Doiron C, Leveridge MJ. The dramatic increase in social media in urology. *J Urol*. 2014;192:494–498.
6. Warren HR, Raison N, Dasgupta P. The rise of altmetrics. *JAMA*. 2017;317:131–132.
7. Weller K. Social media and altmetrics: an overview of current alternative approaches to measuring scholarly impact. In: Welpel IM, Wollersheim J, Ringelhan S, Osterloh M, eds. *Incentives and Performance: Governance of Research Organizations*. Cham: Springer International Publishing; 2015:261–276.
8. Eysenbach G. Can tweets predict citations? Metrics of social impact based on Twitter and correlation with traditional metrics of scientific impact. *J Med Internet Res*. 2011;13:e123.
9. Costas R, Zahedi Z, Wouters P. Do “altmetrics” correlate with citations? Extensive comparison of altmetric indicators with citations from a multidisciplinary perspective. *J Assoc Inf Sci Technol*. 2015;66:2003–2019.
10. Konkiel S, Sugimoto C, Williams S. The use of altmetrics in promotion and tenure. *EDUCAUSE Rev*. 2016;54–55.
11. Holden G, Rosenberg G, Barker K. Bibliometrics: a potential decision making aid in hiring, reappointment, tenure, and promotion decisions. *Soc Work Health Care*. 2005;41:67–92.
12. Gast KM, Kuzon Jr. WM, Waljee JF. Bibliometric indices and academic promotion within plastic surgery. *Plast Reconstr Surg*. 2014;134:838e–844e.
13. Cabrera D. Mayo clinic includes social media scholarship activities in academic advancement. Mayo Clinic Social Media Network Blog 2016. Available at: <https://socialmedia.mayoclinic.org/2016/05/25/>

mayo-clinic-includes-social-media-scholarship-activities-in-academic-advancement/, accessed November 5, 2018.

14. Chung A, Woo H. Twitter in urology and other surgical specialties at global conferences. *ANZ J Surg.* 2016;86:224–227.
15. Rivas JG, Socarras MR, Blanco LT. Social media in urology: opportunities, applications, appropriate use, and new horizons. *Cent Eur J Urol.* 2016;69:293–298.
16. Calopedos RJS, Garcia C, Rashid P, Murphy DG, Lawrentschuk N, Woo HH. Citation indices for social media articles in urology. *BJU Int.* 2017;119(Suppl 5):47–52.
17. Gill BC, Ericson KJ, Hemal S, Babbar P, Shoskes DA. The digital footprint of academic urologists: where do we stand? *Urology.* 2016;90:27–31.
18. Borgmann H, Loeb S, Salem J, et al. Activity, content, contributors, and influencers of the Twitter discussion on urologic oncology. *Urol Oncol.* 2016;34:377–383.

EDITORIAL COMMENT



Bibliometrics aim to determine the scientific impact of a source item; eg, a medical research publication. However, the internet and social media have changed the way medical researchers disseminate and consume scholarly work. Twitter is arguably the most widely used social media platform in academic medicine and urology has been at the forefront of academic tweeting.¹ In addition to expediting and facilitating knowledge transfer, Twitter extends the reach of medical research beyond fellow physicians.

Altmetrics measure the real-time digital attention garnered by a source item by analyzing its mentions in mainstream media, blogs, and on social media sites such as Twitter. Traditional bibliometrics overlook the digital impact of medical research and take years to quantify the impact of a source item. In this study, the authors sought to quantify the association between altmetrics and bibliometrics by comparing Twitter mentions and citation counts.

The authors quantified Twitter mentions of original research articles from the January 2015 print publication of 7 prominent urology journals. The number of Twitter mentions was compared to citation counts 3 years after publication. About three-quarters of these articles were mentioned at least once on Twitter and virtually all Twitter activity ceased 1 year after print publication. The authors found that tweeted articles had twice the number of citations compared to nontweeted articles. An additional increase in citation count was seen for publications tweeted by 1 of its authors.

This article is limited by a small sample size; however, we can conclude that the immediate digital attention received by a publication may reflect its long-term scientific impact. Alternatively, tweeted articles may prime the research community to recall and cite the article at a later date. Future work in this space should aim to adjust for confounders such as the number of Twitter followers or the journal's impact factor. Also, studies should avoid emphasizing a causal effect on traditional bibliometrics, as the purpose of altmetrics is to transcend the established measures of scholarly success.²

Altmetrics quantify the broader impact of a publication on society. Unlike the citation count or *h*-index, these measures capture references within public policy documents, patents,

Wikipedia pages, and the popular press.³ We as a profession should determine how altmetrics are to be valued. Bibliometrics are strongly considered in academic promotion review, grant funding, and committee membership.⁴ Is it time to consider evaluating researchers and educators on not only their *h*-index, but also their digital presence?

Lee A. Hugar, Timothy D. Averch, Palmetto Health USC Medical Group, Division of Urology

References

1. Loeb S, Bayne CE, Frey C, Davies BJ, Averch TD, Woo HH, Stork B, Cooperberg MR, Eggener SE. Use of social media in urology: data from the American Urological Association (AUA). *BJU Int.* 2014;113:993–998.
2. Priem J, Taraborelli D, Groth P, Neylon C. Altmetrics: a manifesto. <http://altmetrics.org/manifesto>.
3. Konkil S, Sugimoto C, Williams S. The use of altmetrics in promotion and tenure. *Educ Rev.* 2016;51:54–55.
4. Valsangkar NP, Zimmers TA, Kim BJ, et al. Determining the drivers of academic success in surgery: an analysis of 3,850 faculty. *PLoS One.* 2015;10:1–17.

<https://doi.org/10.1016/j.urology.2018.08.042>
UROLOGY 123: 32, 2019. © 2018 Elsevier Inc.

AUTHOR REPLY



The widespread dissemination and accessibility of scholarly articles on the internet has led to the advent of “altmetrics” which quantify the online reach of a publication. This is in comparison to more traditional bibliometrics which use citation number to generate an estimation of impact. Previous studies into nonmedical literature have found that “highly-Tweeted articles were 11 times more likely to be highly cited than less-Tweeted articles.”¹

We sought to determine if this relationship holds true in the urologic literature. As the commentator mentioned Twitter is one of the more prominent social media platforms for urology.^{2–4} This can be seen in the increased Twitter activity at academic urology conferences, uptick in publications regarding urology and social media, and the presence of well-known individual Twitter accounts such as that of Stacy Loeb (@LoebStacy, 11K followers) and Matt Cooperberg (@dr_coops, 6.4K followers).

The primary objective of our study was to quantify the relationship between the number of Twitter mentions and the number of academic citations a urology publication receives. Our study found that about 75% of all Twitter activity happens in the period between online and print publication. When an article is mentioned on Twitter it was associated with a 2-fold increase in traditional citations.

Yet our study is not without limitations. In our opinion, it should be viewed more as a proof of concept that it is possible to quantify the connection between Twitter and academic literature. We recognize the inherent nature of social media is that of constant change, and that our specific numbers represent a snapshot in time.

The strength of the study comes from the evaluation of a wide variety of urologic topics and journals, and we believe that the findings go along with the trend toward increased use of social media in academics. It also supports institutional policy changes that now include online presence and prestige in evaluation of faculty advancement.⁵

Although we do not propose there is a causal relationship between Twitter mentions and academics, we do believe that social media may play a role in how academic research will be evaluated in the future. In the spirit of the article we would like to keep the conversation going in real time, so please feel free to reach out in the Twittersphere. @MMSiddiquiMD @SolomonHayon.

Solomon Hayon, Hemant Kumar Tripathi, Ian M. Stormont, Meagan M. Dunne, Michael J. Naslund, Mohummad M. Siddiqui, University of Maryland School of Medicine, Baltimore, MD; Division of Urology, University of Maryland Medical Center, Baltimore, MD

References

1. Eysenbach G. Can tweets predict citations? Metrics of social impact based on Twitter and correlation with traditional metrics of scientific impact. *J Med Internet Res*. 2011;13:e123.
2. Loeb S, Bayne CE, Frey C, et al. Use of social media in urology: data from the American Urological Association (AUA). *BJU Int*. 2014;113:993–998.
3. Calopedos R, Garcia C, Rashid P, Murphy D, Lawrentschuk N, Woo H. Citation indices for social media articles in urology. *BJU Int*. 2017;119(Suppl 5):47–52.
4. Bayne CE, Murphy DG, Loeb S. #Urology is trending in social media. *Rev Urol*. 2014;16:152–154.
5. Cabrera D. Mayo Clinic includes Social Media Scholarship Activities in Academic Advancement. Mayo Clinic Social Media Network Blog 2016. Available at: <https://socialmedia.mayoclinic.org/2016/05/25/mayo-clinic-includes-social-media-scholarship-activities-in-academic-advancement/>, accessed November 5, 2018.

<https://doi.org/10.1016/j.urology.2018.08.043>
UROLOGY 123: 32–33, 2019. © 2018 Elsevier Inc.