INTRODUCTION

Social media use is becoming increasingly common among both healthcare consumers and urologists. A recent Pew Research Center study showed that the number of US internet users active on social media has increased from 8% in 2005 to 74% in 2014 [1]. Urologists are also part of this trend; in 2014, 50-70% of urologists were reported to be active on some form of social media [2]. Urologists currently use social media for a variety of reasons, including discussing patient cases, sharing patient education materials, creating forums to discuss journal articles, and connecting attendees at large academic conferences [3, 4]. Beside these, there are numerous academic advantages to social media use as a urologists’ professional network is expanded, new opportunities for academic collaboration, and increased citation potential for papers [5]. However, another presumed intent of social media among physicians is to promote their practice to prospective patients. Despite this, to date there has been no published literature on the impact of social media on public perception of providers or business productivity.

While surgical volume is a clear indicator of business productivity, public perception is a more intangible concept that is difficult to measure. However, online physicians ratings may be a reasonable proxy for the public’s perception of a physician, based on the scope of use and impact of online ratings on healthcare consumers’ behavior. In the United States, 47% of patients perform online searches of their physicians [6] and a recent population-based analysis of 600 physicians showed a median of 7 reviews per provider [7]. These ratings are frequently used as a key source of information by which patients choose a physician. In fact, a survey of 1000 surgical patients at Mayo clinic found that 81% would seek consultation from a physician based on positive reviews alone, and 77% would not
seek consultation from a physician based solely on negative reviews [8]. Similar data has been reported in Europe [9]. Because of the strong impact of online ratings on healthcare consumers’ choices, it may be reasonable to use them as a proxy measure “community reputation,” if this is defined as how likely a patient is to choose to consult with a given practice based on community opinions.

In this study, we sought to determine whether social media presence among urologists impacts their reputation in the community (vis-à-vis their online consumer rating) and their surgical volume. To address this, we sampled 195 California urologists rated on the Propublica website to determine whether professional use of social media platforms (Facebook, Instagram, Twitter, Blog, YouTube) was associated with: (1) average numeric physician rating across five popular websites and (2) radical prostatectomy surgical volume in 2014 as determined by the Medicare Physician and Other Supplier Public Use File. Recognizing the potential for confounding by institutional branding and practice setting, we corrected for whether the urologist was affiliated with an academic or private practice and did subgroup analysis to determine if effect size was consistent. We hypothesized that physicians with a more active social media presence would have higher online physicians ratings and higher surgical volume.
MATERIALS AND METHODS

Data Source and Participants

The Cedars-Sinai Institutional Review Board certified this study as exempt (IRB #00050328). This study was conducted in accordance with all relevant guidelines and procedures of Cedars-Sinai Medical Center. We sampled all California urologists rated on the ProPublica Surgeon Scorecard website (n=195). These urologists were identified as having completed at least 20 radical prostatectomy or transurethral resection of the prostate (TURP) procedures in calendar year 2014 according to Medicare claims data [10]. Physicians were excluded from the online review portion of the analysis if they had no online reviews (n=12). Physicians were excluded from the surgical volume portion of the analysis if they performed less than 20 radical prostatectomies in calendar year 2014 (n=110).

Variables

Primary Predictor

Physician Social Media Presence. One of the investigators (JH) collected data on physician’s professional social media presence in calendar year 2014 on five popular social media platforms: Facebook®, Instagram®, Twitter®, YouTube®, and professional blog. Social media presence was considered as a binary variable (yes/no), defined as any social media posts promoting their medical practice. We coded social media presence both at the level of the individual platform and also across all platforms. We also collected data on frequency of posts, but elected not to subdivide our sample based on this characteristic given uniformity
of frequency (90% posted information on social media once a month, and only 10% posted information with greater or lesser frequency).

**Covariates**

We gathered demographic data on physicians in our sample, including practice setting (academic or private), years since medical school graduation, location of medical school (domestic or international) from the California Medical Board website.

**Outcomes**

*Online Physician Ratings.* We collected online ratings for each physician across the 5 most popular online physician-rating platforms according to Google Trends: HealthGrades, Vitals, Yelp, RateMD, and UCompareHealth. Each of these websites asks consumers to rate physicians using a "5-star" scale. Using this data, we calculated each physician’s “average rating” as a weighted average of scores across the five websites, weighted by number of reviews on each website.

*Physician Surgical Volume.* We collected data on 2014 radical prostatectomy Medicare claims from the Medicare Physician and Other Supplier Public Use File [11]. We linked this data to other data sources using National Physician Identifier (NPI) numbers. We defined radical prostatectomy as Current Procedural Terminology (CPT) claims codes 55840, 55842, and 55845.

**Statistical Analysis**
We compared characteristics of our sample population by activity on social media, using the chi-squared test for categorical variables and the Wilcoxon-Mann-Whitney test for nonparametrically distributed dependent variables.

We used multivariable linear regression analysis to assess the association of physician social media presence with online physician ratings. Our primary predictor in these models was social media presence, and the outcome was average online physician rating across the five websites. Covariates included practice setting, years since medical school graduation, and location of medical school. We created separate models to analyze the impact of social media presence on any platform and on individual social media platforms on online physician ratings. We also performed sensitivity analyses of our aggregate model in subgroups of academic and private physicians.

We assessed the association of physician social media presence on physician surgical volume in a similar fashion, utilizing multivariable linear regression analysis and identical predictor and covariate structure. We created separate models to analyze the impact of social media presence on any platform and on individual social media platforms on radical prostatectomy volume. We also performed sensitivity analyses of our aggregate model in subgroups of academic and private physicians.
RESULTS

Characteristics of our sample across those active on social media versus not active are reported in Figure 1. Of 195 California urologists, 62 (32%) were active professionally on some form of social media in calendar year 2014, including 53 (27%) on YouTube, 15 (8%) on Facebook, 14 (7%) on Twitter, 10 (5%) on Blog, 6 (3%) on Instagram (Figure 1).

Multivariable logistic regression models predicting the weighted average of online physician rating scores showed that social media presence on any platform was associated with a significantly higher mean physician rating ($\beta$ coefficient 0.3, 95% CI 0.03–0.5, p=0.05) (Figure 2). A similar magnitude and direction of effect persisted among subgroups of private ($\beta$ coefficient 0.2, 95% CI -0.1–0.5, p=0.2) and academic physicians ($\beta$ coefficient 0.6, 95% CI 0.15–1.0, p=0.01) in sensitivity analyses. However, in multivariable models assessing the association of individual social media platforms with online ratings, only YouTube was associated with significantly higher mean physician rating ($\beta$ coefficient 0.3, 95% CI 0.2–0.5, p=0.04). There were no meaningful or statistically significant differences in online physician ratings associated with use of other social media platforms.

Multivariable logistic regression models predicting surgical volume showed that social media presence on any platform was associated with a trend toward higher annual radical prostatectomy volume ($\beta$ coefficient 7.1, 95% CI -0.7–14.2, p=0.05) (Figure 3). A similar magnitude of effect was observed among subgroups of private ($\beta$ coefficient 7.1, 95% CI -0.9–15.2, p=0.08) and academic ($\beta$ coefficient 6.7, 95% CI -11.3–24.8, p=0.4) physicians in sensitivity analyses. In multivariable models assessing the association of individual social media platforms with surgical volume, presence on YouTube was significantly associated with higher annual radical prostatectomy volume ($\beta$ coefficient 7.4,
95% CI 0.3–14.5, p=0.04) (Figure 3). There was no statistically significant difference in surgical volume associated with use of other social media platforms.
DISCUSSION

While physicians are increasingly using online social media to interact with their patients and promote their practices, it is to date unknown whether this activity has any demonstrable effect on productivity outcomes. Our study suggests that professional activity on social media sites may positively impact both the physician’s reputation within the patient community as well as their surgical volume. We found that social media activity on any of the five social media outlets studied (and YouTube specifically in subgroup analysis), had a statistically significant association with online physician ratings, with an average increase of 0.3 over physicians who were not active on social media. Although a 0.3 increase on a 5-point scale seems small, it represents a difference of 0.4 standard deviations from the mean, indicating a meaningful difference. We also found that presence on any one of the five social media sites was associated with a trend toward increased prostatectomy volume, with a statistically significant increase noted among those active on You Tube. A urologist who posts videos on social media is likely to perform roughly 7 more radical prostatectomies per year than a urologist who does not post videos (representing an average increase of roughly 25% over the mean annual rate of 27 prostatectomies).

This is the first study to our knowledge to directly test the association between social media use and clinical productivity outcomes. Other surgical specialties have speculated on the advantages in clinical efficiency and productivity afforded by social media outreach but have not engaged in formal hypothesis testing. Orthopedic surgeons have postulated that directing patients to social media sites focused on patient education may enable more efficient and effective communications with their patients, reducing patient phone call volume and increasing clinical efficiency [12]. Vascular surgeons have suggested the utility of social media outreach in circumventing traditional physician
referral patterns, providing an advantage in gaining market presence [13]. Yet despite clear interest in the association between social media use and real-world outcomes, there remains a lack in evidence-based testing of these associations. Our study, while limited due to its retrospective design, provides some evidence for the purported utility of professional use of social media.

Our finding that YouTube is the social media form with the strongest impact on a physician’s online reputation and surgical volume pairs well with recent data showing that healthcare consumers can accurately identify quality of surgery by watching online samples of a surgeon’s technique. A recent study showed that medically trained reviewers were able to identify surgeons with higher complication rates by watching videos of their technique in the context of laparoscopic bariatric surgery [14]. Surprisingly, healthcare consumers (via crowdsourcing among the general population) were also able to identify surgeons with higher complication rates by watching videos of their operative technique in the context of robotic radical prostatectomy [15]. Based on this data, patients may be justified in choosing surgeons who post videos online, since they appear to be able discern good from bad surgeons by viewing examples of their best work.

Professional use of social media is one of a number of sources of information that contribute to a physician’s “online dossier,” and both healthcare consumers and physicians should be aware of the relative worth of each component. The comprehensive online data available to healthcare consumers in choosing a physician include social media activity, online physician ratings, quality metrics, surgical volume, office ratings, and publically available personal information. While this study highlights the importance of social media presence in cultivating an online persona, the other components undoubtedly can (and should) contribute to a patient’s overall perception of a physician. For example, we recently
argued that online ratings data should not be used as the sole criterion by healthcare consumers to select physicians (as data suggests they are), since they have no association with quality or value of care [16]. Similar to online ratings, social media presence should not be used by patients in isolation to select physicians. Ideally, physicians and patients will consider social media activity in the context of other sources of information that provide independent information about the physician, such as data that captures quality of care (surgical volume, quality metrics, and complexity of case volume), value of care, and the patient experience (online ratings).

This study has several limitations that may affect our findings. First, the association of social media presence with reputation and productivity outcomes may be confounded by institutional branding. However, the magnitude of association was virtually identical for subsets of private and academic physicians, which suggests that the findings are robust across different practice settings. Second, we are unable to rule out reverse causality as an explanation for our findings (i.e. whether being a high-volume, highly rated surgeon is predictive of activity on social media). However, even if some degree of reverse causality exists, the policy implication is still identical: that more surgeons should be posting videos online in order to prove the adequacy of their skills compared to their peers. Finally, the observational nature of this study may incur selection bias, since it only includes California urologists who are performing a minimum of twenty urologic procedures (TURP, radical prostatectomy) per year. Considerations for future prospective study design could include an interrupted time series or a randomized controlled study.

CONCLUSIONS
Though most California urologists were not active on social media, we found that professional use of social media was associated with higher online physician ratings and increased prostatectomy volume. These findings suggest that urologists should consider being active on social media to promote and build their professional practice. Given the trajectory of use of online resources such as online ratings in selecting providers, we believe that the use of social media will become an increasingly important outreach tool for clinicians to interact with their patients in a meaningful way.

Authors Contributions

All Authors researched, collaborated, and wrote this paper.

Conflict of Interests

No author included in this study has any financial conflict of interest relevant to the publication of this article.

Data Availability

All data that was used in publishing this paper remain available.
REFERENCES