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Application of sentiment and word frequency analysis of physician review sites to evaluate refractive surgery care

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ABSTRACT

Background: Online physician reviews increase transparency in health care, helping patients make informed decisions about their provider. Language processing techniques can quantify this data and allow providers to better understand patients' experiences, perspectives, and priorities. The objective of this study was to assess patient satisfaction and understand the aspects of care that are valued by patients seeking refractive care using sentiment and word frequency analysis.

Methods: Written reviews and Star ratings for members of the Refractive Surgery Alliance Society practicing in the United States were collected from Healthgrades, a popular physician rating website. Surgeons with at least one written review were included in the study. Reviews were scored from -1 (most negative) to +1 (most positive) using Valence Aware Dictionary sEntiment Reasoner (VADER). Reviews were stratified by demographic characteristics, namely gender, region, and years in practice. Word frequency analysis was applied to find the most common words and phrases.

Results: A total of 254 specialists and 3104 reviews were analyzed, with an average of 4.4/5 stars and mean 48 ratings each. Most physicians had positive reviews (96%, average VADER = 0.69). Younger physicians (<20 years since residency) had significantly higher Stars rating than senior peers (>20 years) ($P < 0.001$). A similar trend was observed in VADER score (0.71 vs 0.69), although not statistically significant ($P = 0.06$). No statistical differences were observed between Stars rating and VADER score by gender ($P = 0.66$, $P = 0.83$) or by geographical region ($P = 0.74$, $P = 0.07$). "Staff" ($n = 1269$), "professional" ($n = 631$), "office" ($n = 523$), "questions" ($n = 424$), and "friendly" ($n = 386$) were frequently used in reviews, along with phrases such as "the staff" ($n = 273$) and "my questions" ($n = 174$). "Surgery" ($n = 719$), "staff" ($n = 576$), "procedure" ($n = 251$), "experience" ($n = 243$), and "professional" ($n = 240$) were the most common words in positive reviews, while "surgery" ($n = 147$), "office" ($n = 86$), "staff" ($n = 54$), "time" ($n = 47$), and "insurance" ($n = 28$) were the most commonly used in negative reviews.

Conclusions: Both the average Stars and VADER sentiment score suggest a high satisfaction among refractive patients. Word frequency analysis revealed that patients value non-clinical aspects of care, including interactions with staff, insurance coverage, and wait-times, suggesting that improving non-clinical factors could enhance patient satisfaction with refractive surgery.

1. Introduction

The rise of Physician Rating Websites (PRWs), such as Healthgrades, has greatly increased transparency of the healthcare system. PRWs allow patients to read the experiences of others with an individual doctor or a group of physicians, affecting a patient's choice regarding who cares for them. The National Research Corporation Health reported 37% of patients used PRWs for a preliminary search for a healthcare provider while 61% of patients used PRWs as a deterrent for healthcare providers with poor reviews in 2018.[1,2] Patient feedback may also benefit physicians

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seeking to improve their practice.[3] Previous analysis of online patient reviews revealed that the physician-patient interaction significantly affects a patient's review.[4,5] However, the variables impacting this interaction are difficult to quantify, and may vary based on medical specialty.

One form of analysis that may be deployed on PRW patient reviews is Valence Aware Dictionary for sEntiment Reasoning (VADER). VADER is a computational sentiment analysis tool that quantifies a writer's attitude, emotions, or judgements.[6] It considers punctuation and capitalization in addition to lexicon to determine the magnitude of emotions or sentiments and then assigns a score. VADER has been previously utilized in studies investigating the emotional tone of comments on online social media platforms such as Reddit,[6] Twitter,[7,8] and in healthcare on PRW to evaluate patient reviews.[3,4,9] Within ophthalmology, VADER analysis of PRWs, such as Healthgrades, has identified overall positive sentiment among patients, with specific concerns surrounding wait times and staff for pediatric ophthalmology and glaucoma providers.[4,5]

Previous literature has also evaluated patient satisfaction in ophthalmology using other methods, such as through surveys[10,11] and standardized questionnaires.[12,13] However, current literature lacks data on the quantification of patient sentiment on PRWs for some specialties. Refractive surgery is an ophthalmic sub-specialty focused on improving primarily uncorrected vision by modifying the lens and/or cornea. Common surgical procedures in refractive surgery include small incision lenticule extraction (SMILE), photorefractive keratectomy, and the EVO Implantable Collamer Lens.[14] The most common corneal procedure performed by refractive surgery ophthalmologists is laser assisted in-situ keratomileusis (LASIK), and the most common lens based refractive surgery remains cataract surgery.[15] Refractive surgery is expected to increase in frequency as the world population's myopia epidemic grows.[16] Although refractive procedures generally have very high success rates and patient satisfaction, patient satisfaction has previously only been evaluated in reference to clinical aspects of care, such as their changes in visual acuity[17] or intraocular lens type.[18]

Therefore, the objective of this study was to quantify and evaluate patient sentiment within refractive surgery using VADER language analysis and word frequency analysis of a popular PRW, Healthgrades. This data may be important for refractive care providers to identify patterns in patient satisfaction and therefore improve healthcare delivery.

2. Methods

A list of physicians for inclusion in this study was curated by searching for refractive surgery specialists listed in the membership directory of the Refractive Surgery Alliance Society. Inclusion criteria required physicians to be practicing in the United States (US) and have publicly available demographic information. Inclusion also required physicians to have a profile on Healthgrades (healthgrades.com), which listed at least one Stars rating and at least one written review.

Demographic information was collected on physicians using institutional websites and other publicly available sources, such as Doximity and LinkedIn. The data recorded included physician gender, region of practice, as defined by the US Census Bureau (Northeast, Midwest, South, West),[19] and residency graduation year. The physician's residency graduation year was subtracted from 2023 to estimate his/her years in practice. Years in practice were stratified as less than 20 or 20 or more years.

On Healthgrades, the number of Stars reviews, average Stars rating, number of written reviews, and the written reviews were noted. For physicians with over 50 written reviews, the first 50 were recorded to ensure recency of comments in correlation with the physician's years in practice. Reviews not written in English were excluded. No additional exclusion criteria were applied to reviews, therefore any services or procedures provided by the physicians (consultations, cataract surgeries, corneal refractive surgeries, etc) may be commented upon in the reviews. Each review was analyzed using the VADER Python package to calculate

a Negative, Neutral, Positive, and Compound score. The sum of the Negative, Neutral, and Positive scores for each input is equivalent to one, as they each represent the degree to which the statement is negative, neutral, or positive, respectively. Compound scores, ranging from -1 as the most negative and $+1$ as the most positive, take into consideration these three factors and produce an output summarizing the overall sentiment. Reviews were also grouped by physician and inputted into VADER to calculate overall sentiment scores for each physician.

Average Stars rating and VADER Compound scores were stratified by demographic features to assess differences in patient sentiment based on provider gender, location, and years in practice. Mann-Whitney U tests and Kruskal-Wallis H tests were utilized with an alpha value of 0.05 to assess statistical significance.

Word frequency analysis was also implemented to identify themes and commonly used words within the written reviews. Only words relevant to care delivery or the patient perspective were included; for example, in one-word strings, words such as "good" or "best" were excluded, as they do not provide specific insight into medical care. Similarly, articles and prepositions were excluded from one-word strings. In bigrams (two-word strings), trigrams (three-word strings), and four-word strings, repeats were also excluded ("a surgery" versus "the surgery"). Across all reviews, the 10 most frequently used words (one word string) and bigrams were recorded, as well as the five most highly represented trigrams and four-word strings. Reviews were then stratified by most positive (compound score >0.75) and most negative (compound score <0).[3] The five most common words and bigrams were recorded within these stratifications.

3. Results

A total of 254 refractive specialists and 3104 Healthgrades reviews fit our inclusion criteria for analysis. Demographic stratification of these specialists found 84.3% to be male. The majority of physicians were located in the South (40.2%), followed by the West (28.7%), Midwest (15.7%), and Northeast (15.4%). Fifty-two percent of physicians had been in practice for less than 20 years, compared to 48% who had 20 or more years of experience (**Table 1**).

3.1. Differences in patient sentiment by demographic features

The overall mean Stars rating was 4.38/5 stars, and each physician had an average of 48 ratings. Physicians had an average of 19 written reviews each, with a mean VADER Compound score of 0.69. VADER also calculated the Positive, Negative, and Neutral scores for reviews, which on average were 0.27, 0.03, and 0.70, respectively. VADER was also used to classify Compound scores by physician and by review. Analysis by physician found that 96.5% had overall Positive reviews, 3.5% had overall Negative reviews, and no physicians had an overall Neutral score. By rating, our analysis found 88.9% of reviews were Positive, 7.5% were Negative, and 3.5% were Neutral (**Table 2**).

Table 1
Demographic description of physicians included from the Refractive Surgery Alliance Society.

	N	Percentage (%)
Gender		
Men	214	84.3
Women	40	15.7
Area of Practice		
Northeast	39	15.4
Midwest	40	15.7
South	102	40.2
West	73	28.7
Years Since Residency		
Less than 20	132	52.0
20 or more	122	48.0

Table 2
Percentage of Positive, Negative and Neutral ratings by physician and by review.

Overall Rating by Physician	N	Percentage (%)
Positive	245	96.5
Negative	9	3.5
Neutral	0	0
Number of Review Ratings		
Positive	2760	88.9
Negative	232	7.5
Neutral	112	3.6

The overall average Stars ratings and VADER compound score were stratified by physician gender, area of practice, and years since residency. No differences in average Stars rating (4.40 vs 4.30; $P = 0.66$) or Compound score (0.69 vs 0.69; $P = 0.83$) were observed between male and female physicians. Analysis of Stars rating by location identified the highest average Stars ratings in the West (4.42), followed by the South (4.41), Northeast (4.32), and Midwest (4.30). Analysis by Compound score found the highest score in the Northeast (0.70), followed by the South (0.69), West (0.68), and Midwest (0.68). No statistically significant differences in location were observed by Stars ($P = 0.74$) or Compound score ($P = 0.07$). Evaluation of sentiment based on years since residency found statistically significant differences in average Stars rating ($P < 0.001$), and the difference in Compound score was approaching clinical significance ($P = 0.06$). In both metrics, physicians with fewer years in practice had higher ratings than peers with greater years in practice (4.56 vs 4.20 Stars; 0.71 vs 0.67 Compound score) **(Table 3)**.

3.2. Word frequency analysis of written reviews

Word frequency analysis was utilized to identify the most common words and phrases written in reviews **(Table 4)**. Single-word analysis yielded "surgery" (n = 1825), "staff" (n = 1269), "professional" (n = 631), "procedure" (n = 599), and "experience" as the five most frequently mentioned words, followed by "office" (n = 523), "lasik" (n = 500), "questions" (n = 424), "friendly" (n = 386), and "feel" (n = 338). Bigram analysis identified the 10 most frequently used two-word phrases as: "cataract surgery" (n = 504), "his staff" (n = 329), "the staff" (n = 273), "very professional" (n = 209), "my questions" (n = 209), "the office" (n = 151), "the results" (n = 145), "follow up" (n = 113), "answered all" (n = 93), and "my experience" (n = 93). The five trigrams that appeared most frequently were "made me feel" (n = 121), "answered my questions" (n = 92), "with the results" (n = 89), "the time to" (n = 77), and "and his team" (n = 70). The five most common four-word strings were "answered all my questions" (n = 55), "took the time to" (n = 47), "from start to finish" (n = 35), "all of my questions" (n = 34), "made me feel comfortable" (n = 30).

Reviews were also stratified by most positive and most negative. Of

Table 3
Average Stars rating and VADER Compound Score by physician gender, area of practice, and years in practice.

	Average Stars Rating (STDEV)	Average VADER Compound Score
Physician Gender		
Men	4.40 (0.68)	0.69 (0.87)
Women	4.30 (0.86)	0.69 (0.87)
P Value	0.66	0.83
Area of Practice		
Northeast	4.32 (0.83)	0.70 (0.41)
Midwest	4.30 (0.71)	0.68 (0.45)
South	4.41 (0.74)	0.69 (0.42)
West	4.42 (0.61)	0.68 (0.47)
P Value	0.74	0.07
Years Since Residency		
Less than 20	4.56 (0.72)	0.71 (0.40)
20 or more	4.20 (0.66)	0.67 (0.46)
P Value	<0.001	0.06

Table 4
Most commonly used words and phrases across all reviews.

Single Word Analysis		Bigram Analysis	
Word	Frequency	Word	Frequency
surgery	1825	cataract surgery	504
staff	1269	his staff	329
professional	631	the staff	273
procedure	599	very professional	209
experience	526	my questions	174
office	523	the office	151
lasik	500	the results	145
questions	424	follow up	113
friendly	386	answered all	93
feel	338	my experience	93
Trigram		**Four-Word String**	**Four-Word String**
Word	**Frequency**	**Word**	**Frequency**
made me feel	121	answered all my questions	55
all my questions	92	took the time to	47
with the results	89	from start to finish	35
the time to	77	all of my questions	34
and his team	70	made me feel comfortable	30

the most positive reviews (Compound score >0.75; n = 1029), "surgery" (n = 719), "staff" (n = 576), "procedure" (n = 251), "experience" (n = 243), and "professional" (n = 240) appeared most frequently. Bigrams including "his staff" (n = 153), "the procedure" (n = 123), "the surgery" (n = 121), "very professional" (n = 67), and "lasik surgery" (n = 57) also had high representation (Fig. 1).

Of the most negative reviews (Compound score <0; n = 239), the most frequently used words were "surgery" (n = 147), "office" (n = 86), "staff" (n = 54), "time" (n = 47), and "insurance" (n = 28). Similarly, the most frequently used two-word strings were "the office" (n = 35), "my insurance" (n = 19), "the staff" (n = 13), "follow up" (n = 11), and "to wait" (n = 10) (Fig. 2).

4. Discussion

Online PRWs now play a great role in guiding patients as they search for a provider.[20] Many refractive procedures, such as LASIK, are elective, likely driving patients to rely heavily on PRWs when choosing a provider for their care. This highlights the necessity for ophthalmologists to better understand these online review and rating platforms. In this study, we evaluated patient sentiment of 3104 Healthgrades reviews of 254 refractive specialists using VADER language analysis and word frequency analyses. We observed overall high satisfaction, with an average of 4.38/5.00 Stars and an average Compound score of 0.69. To our knowledge, this is the first large study evaluating sentiment of written patient reviews of refractive surgeons. Our analysis suggests higher satisfaction among patients treated by junior refractive surgeons, and that non-clinical factors greatly impact written reviews.

4.1. Surgeon characteristics

Previous studies have been divided on the impact of surgeon gender on online physician ratings and reviews. Some studies have demonstrated a difference in ratings based on sex, while others have not.[21,22] These differences may be attributable to unmodifiable factors, as some studies have suggested patient preference for physician-patient gender concordance,[23] while other studies suggest that physician-patient gender concordance may affect patient outcomes.[24] Some analyses have also found gender differences in the physician practice patterns that may affect satisfaction, such as focus on preventative care[25] and emphasis on patient-centered care.[26] Within ophthalmology, Jo et al. reported higher satisfaction scores among male ophthalmologists,[22] however Smith et al. found no gender differences.[21] Our findings did not demonstrate any differences in satisfaction between male and female refractive surgeons (P (Stars) = 0.66; P (Compound) = 0.83). However, this finding may be
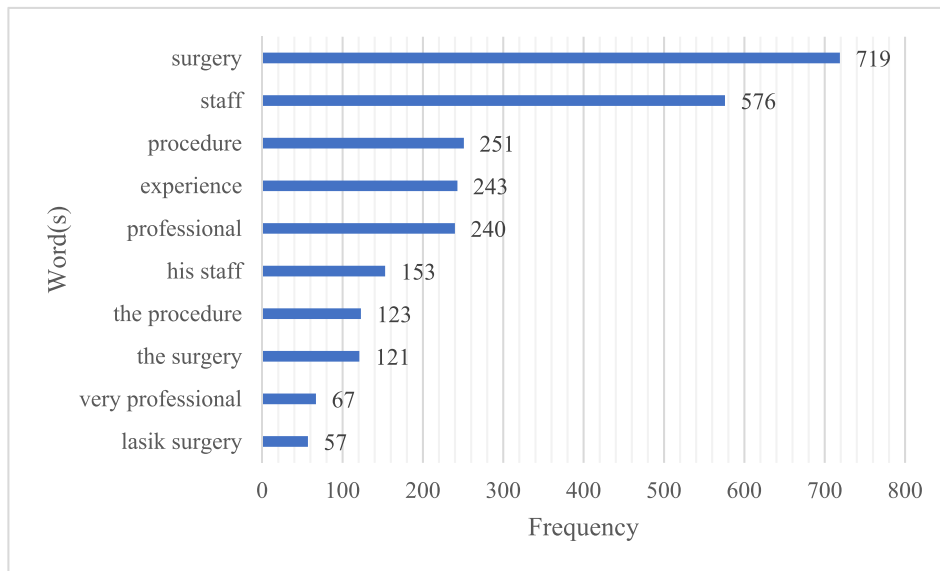
Fig. 1. Most frequently used words and bigrams in the most positive reviews (VADER Compound >0.75).
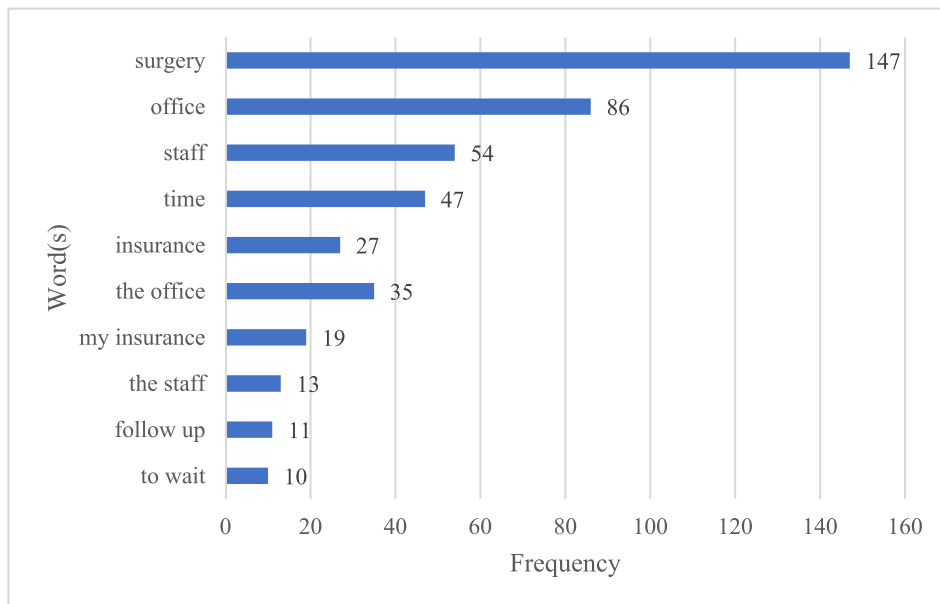

Fig. 2. Most frequently used words and bigrams in the most negative reviews (VADER Compound <0).

impacted by the high proportion of male refractive surgeons in this study.

Geographical region analysis showed no statistically significant difference for Stars ratings ($P = 0.74$) or VADER Compounds scores ($P = 0.07$). Although we did not observe geographical variations in patient satisfaction, other studies have found differences between rural and urban areas, both in the emphasis placed on aspects of care and access to specialists.[27] Regional variations have also been observed in both patient and physician demographics,[28] as well as socioeconomic status,[29] both of which may also affect patient satisfaction.

Previous literature has found more positive reviews for younger surgeons compared to more senior counterparts.[21,22] Our study demonstrated that refractive surgeons with fewer years in practice also received higher Star ratings ($P < 0.001$) and VADER compound score ($P = 0.06$) on Healthgrades. These findings correspond with the trend of younger physicians being more highly rated that seen in ophthalmology and other specialties.[3] This may be attributable to the role PWRs play in a physician's practice. Younger physicians may be more aware of such rating

sites, as they may feel more comfortable utilizing web-based resources and interacting with patients online. Similarly, more junior physicians may also be more active in career development and reputation-building, and therefore more conscious of PWRs.

4.2. Positive and negative written reviews

Non-clinical aspects of care such as wait-time and staff, and personal characteristics such as professionalism, were heavily represented in written reviews. We found the top five most common words used in positive reviews to be "surgery", "staff", "procedure", "experience", and "professional". Bigram analysis showed the top five most common word-pairs in positive reviews to be "his staff", "the procedure", "the surgery", "very professional", and "lasik surgery". In comparison, the five most common words and phrases used in negative reviews were related to the office staff, follow up, and insurance. With respect to word-pair frequency, the bigrams most likely associated with negative reviews were

"the office" and "my insurance".

Previous studies have demonstrated that patients, in ophthalmology and other specialties, may base their reviews on the office staff interactions and perceived staff professionalism and friendliness.[20,21,30] Similarly, based on our sentiment analysis, patients appear to highly value their interactions with office staff in addition to the surgical experience. While surgeons can encourage a professional environment and manage office staff, most refractive surgeries are elective and vary in their healthcare coverage. Despite this reality, the lowest rated reviews placed a greater emphasis on insurance coverage and acquiring appointments, both of which have been identified in other studies as factors important for patient satisfaction.[31–33] We found that patients who wrote negative reviews often had negative experiences with their insurance, therefore it may be important for refractive practices to emphasize other forms of cost coverage such as interest-free healthcare-specific payment plans or the use of flexible spending accounts to assist in patient payment for refractive procedures. Regardless, these non-clinical aspects play a determinant role in the patient experience and work in tandem with the actual surgical experience.

4.3. Study limitations

One limitation of this study was the retrospective nature of our methods. As reviews were not stratified by procedure type, our findings may have been biased towards procedures with higher representation. Although many patients did not mention what procedure or service they were receiving, the frequency of the "lasik" and "cataract surgery" implies that a significant proportion of the reviews may have been focused on a few procedures. In addition, patients with very positive or very negative experiences may be more likely to leave a review online, so our data may capture individuals with a more polarized outlook on their care. Furthermore, patients who have strong relationships with their physician can be encouraged by the physician to leave a review. In that vein, there may be a bias towards satisfied reviews. Lastly, older patients who may be less comfortable with technology and patients who are not English speakers may have been less likely to write and post a review. This may have led to an underrepresentation of their perspectives in our data.

In addition, our study utilized reviews from physicians practicing in the United States, therefore our findings may be less generalizable to refractive care in other regions, especially those with different populations and healthcare systems. For instance, East Asia has one of the highest prevalence rates for myopia and refractive error.[34,35] However, significant variations in refractive care access between countries and rural versus metropolitan regions may impact the obstacles faced by individuals seeking care.[34] Differences in healthcare systems, ranging from those which are entirely government funded to those which are entirely privately funded, and those which have a combination of both models, may affect factors such as cost or wait times for patients. In addition, our study evaluated Healthgrades because it is a popular PRW in the United States. In other countries, patients may prefer different websites and methods to evaluate healthcare providers.

5. Conclusions

Our results demonstrated high patient satisfaction among refractive patients and highlighted non-clinical aspects of care, including interactions with office staff, insurance coverage, and wait times, in addition to the bedside manner of the physician, all of which appear to impact patient reviews. Younger surgeons generally had more positive reviews than older surgeons. Patient frustration seems to be associated with the lack of insurance coverage for refractive procedures and negative interactions with staff rather than the surgical care itself. To obtain a more complete analysis of online reviews in the refractive surgery market, future studies could expand their dataset to include other PRWs, such as WebMD and ZocDoc. Overall, our results suggest that focusing on improving these factors could enhance patient experience and online

reviews for refractive surgery.

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