

Perceptions Related to Careers in Nephrology on Student Doctor Network Using Natural Language Processing



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INTRODUCTION

Interest in a career in nephrology has been declining.¹ The ratio of candidates applying to nephrology fellowships per position has been less than 1 since 2016, with the lowest reaching 0.6 candidates per position.² The reasons behind the decreased interest in nephrology have been explored mainly through surveys and interviews.^{3–7} Several factors such as difficulty of the subject, lack of role models, lack of exposure to the field and procedures, perception of low remuneration, and poor work-life balance are important contributors to why nephrology was not chosen. With easy access to unfiltered, diverse content and robust networking interactions, social media has undergone substantial growth over the past decade. Exploring social media conversations about nephrology may provide valuable insights into the reasons for the declining interest in the field.

In this study, we aimed to use natural language processing, a subset of artificial intelligence encompassing the art of teaching computers to understand human language, to explore current perceptions of a career in nephrology shared on public forums. We utilized BERT (Supplemental Figure S1) and ChatGPT (Supplemental Figure S2) to identify, label, and describe topics related to nephrology discussed on student doctor network forums. Sentiment analysis was conducted by 2 independent raters to determine the tone of perceptions

as positive, negative, or neutral/mixed. Full methods are provided in the [Supplementary Methods](#).

RESULTS

A total of 246 potentially relevant threads were discovered. After manual review, 71 threads containing 1946 posts discussing nephrology as a specialty were identified from 2004 to 2022 (Supplementary Figure S3). Nineteen topics were identified by BERTopic. Of the 1946 posts, 925 were categorized into topics whereas the remaining 1021 were uncategorized due to being labeled as outliers in the clustering step. In Supplementary Figure S4, we illustrate the clustering of the topics. The topic keywords generated by BERTopic are documented in Supplementary Table S1. The topic labels covered 2 main themes as follows: (i) career prospects in nephrology (e.g., “attitudes toward nephrology job prospects,” “attitudes toward nephrology in academic and nonacademic settings,” “attitudes toward nephrology,” and “misconceptions and realities of nephrology in private practice”) and (ii) nephrology fellowship and residency programs (e.g., “exploitation of international medical graduates in nephrology fellowship programs,” “attitude toward nephrology fellowship and residency match,” “nephrology as a pathway to critical care medicine,” and “challenges and negative perceptions of nephrology fellowship”) (Table 1).

Table 1. Topic label and topic description

Career prospects of nephrology		
Topic label	Topic description	
1	Attitudes toward nephrology job prospects	<ul style="list-style-type: none"> Highlights the challenges and disappointments faced by nephrologists in terms of starting salaries, partnership opportunities, workload, and income distribution. The overall tone is cautionary, suggesting that potential nephrologists should be aware of the downsides and potential career damage before pursuing the specialty.
2	Attitudes toward nephrology in academic and nonacademic settings	<ul style="list-style-type: none"> Discusses the financial aspects and career prospects of nephrology in academic and nonacademic settings. The authors highlight the potential for higher salaries and better work-life balance in nonacademic fields such as hospitalist positions. They also emphasize the advantages of pursuing nephrology in academic settings, including the ability to choose top programs, receive comprehensive training, and become an academician. Overall, the documents provide insights into the various factors influencing attitudes toward nephrology and the career paths available in this field.
3	Attitudes toward nephrology	<ul style="list-style-type: none"> Mixed opinions on the intellectual nature, workload, and financial prospects of nephrology as a medical specialty.
4	Attitude toward nephrology in private practice	<ul style="list-style-type: none"> Discusses insights and experiences of nephrologists in private practice, highlighting workload, dialysis management, procedures, vacation time, revenue sources, partnership structure, salary, life-work balance, job satisfaction, challenges, and advice for fellows considering nephrology.
5	Misconceptions and realities of nephrology in private practice	<ul style="list-style-type: none"> Discusses the belief that nephrology is poorly reimbursed with a high workload, and how trusted academics may have lied about the financial picture in private practice. It also highlights the harsh realities of private practice compared to academia, and the psychological trap of the sunken cost fallacy that many nephrologists find themselves in. Suggests caution in pursuing nephrology and recommends considering alternatives such as hospitalist positions.
6	Challenges and perceptions of nephrology practice.	<ul style="list-style-type: none"> Highlights the challenges and perceptions surrounding nephrology practice, including the difficulty of establishing a lucrative private practice, the geographic variations in demand, the dominance of chronic HD in generating revenue, the limited profitability of managing patients with CKD, the need for improved lobbying efforts, and the impact of the medical industrial complex on the field.
7	Attitudes toward nephrology in online forums	<ul style="list-style-type: none"> Mixed opinions and experiences shared in online forums regarding the decision to pursue nephrology as a specialty, with some expressing regret and warning others about potential challenges and disappointments.
8	Physician workload and the role of midlevels in health care	<ul style="list-style-type: none"> Discusses the workload and hours worked by physicians, particularly in specialties such as interventional cardiology, nephrology, and hospitalist medicine. There is a mention of the potential for midlevels to replace physicians in certain roles; however, concerns are raised about the ability of midlevels to handle the same workload as physicians. The attitude towards nephrology is that it can be pursued as a secondary specialty, but not at the expense of being underpaid.
9	Attitudes toward nephrology in medical field	<ul style="list-style-type: none"> Mixed opinions on the desirability and competitiveness of nephrology as a subspecialty within internal medicine. Some view it as an escape from general internal medicine, whereas others see it as slower and less lucrative. The lifestyle and practice settings vary, with calls being better than gastrointestinal or cardiology but worse than rheumatology or endocrinology. Nephrology is in the middle of the pack in terms of pay for internal medicine subspecialties. There are differing opinions on the competitiveness of nephrology, with some ranking it as the least competitive specialty and others suggesting it is easier to match into if residency is done from a university program.
10	Challenges in private practice nephrology	<ul style="list-style-type: none"> Highlighting the financial challenges faced by new partners in private practice nephrology due to the lack of new dialysis units and the reluctance of senior partners to share their nonclinical income sources. It also emphasizes the negative impact on high attrition rates and the exploitation of new graduates by older partners. The attitude towards nephrology in private practice is portrayed as financially damaging and potentially leading to destitution and economic exploitation.
11	Renal transplant nephrology and salary	<ul style="list-style-type: none"> Discussing the field of renal transplant nephrology, including salary prospects and lifestyle considerations. It highlights that though it may not be as financially lucrative as general nephrology, it offers interesting cases and the opportunity to work in a specialized field. The starting salary for transplant nephrologists in university programs is about \$200,000 to \$250,000 /yr, whereas in community transplant centers it can be higher, around \$300,000 to \$350,000 /yr. The topic also mentions the importance of interactions with transplant surgeons and the potential for unreimbursed meetings and time-consuming patient care. It notes that chronic dialysis rounding may be easier in terms of income; however, transplant nephrology offers unique experiences and the chance to contribute to research and publish in transplant journals. Overall, the topic suggests that though not highly competitive, a career in renal transplant nephrology can be fulfilling for those with a passion for the field and academic aspirations.
12	Attitude toward midlevels in health care	<ul style="list-style-type: none"> Expresses a negative attitude toward midlevels (nurse practitioners, certified registered nurse anesthetists, and physician assistants) in health care, particularly regarding their ability to think like doctors, their training and experience, and their impact on the quality of care. The documents also mention the increasing presence of midlevels in various health care settings and the potential implications for physicians' roles and salaries.
Nephrology fellowship and residency programs		
Topic label	Topic description	
1	Exploitation of IMGs in nephrology fellowship programs	<ul style="list-style-type: none"> Highlighting the exploitation of IMGs in nephrology fellowship programs, where unfilled spots are filled with desperate applicants who were unable to match into internal medicine residency. The topic reveals a negative attitude toward nephrology, emphasizing its noncompetitiveness, poor lifestyle, and low reimbursement. It also criticizes academic nephrologists for making false promises and misleading applicants about the specialty's financial prospects. The difficulty for IMGs to secure United States residency and job opportunities after fellowship is discussed, along with suggestions to address these challenges.

(Continued on following page)

Table 1. (Continued) Topic label and topic description

		Career prospects of nephrology
Topic label	Topic description	
2	Attitude towards nephrology fellowship and residency match	<ul style="list-style-type: none"> Expressing that there should be zero SOAP/scramble applicants into nephrology fellowship. The author discourages cardiology and PCCM applicants who did not match from accepting cold calls to join nephrology programs, as it is seen as taking advantage of them. The author advises those who did not match into their primary subspecialty to ignore the cold calls and emails and instead do hospitalist or research roles for a year and reapply. The author warns that accepting a scramble program in nephrology may lead to a lower tier program and limited opportunities in academic renal. The author also discusses the challenges faced by residents who scramble into nephrology and later want to apply to cardiology or PCCM, emphasizing the importance of research and connections to be taken seriously by those programs. Encourages residents who genuinely like nephrology to pursue their dreams but expresses skepticism about the success stories of nephrology graduates and highlights the prevalence of hospitalist positions among renal graduates.
3	Medical residency interviews in the 1980s	<ul style="list-style-type: none"> This topic discusses the experiences and interviews of medical residency applicants in the 1980s. It includes information about various programs such as UCSF, UAB, MUSC, and Mount Sinai. The topic also mentions the late interview offers and the attitude towards nephrology during the interviews.
4	Nephrology as a pathway to critical care medicine	<ul style="list-style-type: none"> Discussing the trend of using nephrology as a back door for candidates interested in pursuing critical care medicine (CCM). It highlights the limited number of pure CCM programs and the fierce competition for spots. Nephrology programs are now offering nephrology/CCM tracks to attract candidates; however, the lack of CCM skills during nephrology fellowship puts them at a disadvantage. The discussion also emphasizes the disadvantage of nephrology fellows in terms of ICU training, ultrasound skills, vent management, and hemodynamics. The topic suggests that 1 year of CCM fellowship may not be sufficient to acquire all the necessary skills, making the chances of nephrology candidates getting into CCM through open competition slim.
5	Challenges and negative perceptions of nephrology fellowship	<ul style="list-style-type: none"> Explores the challenges and negative perceptions surrounding nephrology fellowship, including issues with job prospects, low salaries, high workload, and a lack of interest among medical students and graduates.
6	Nephrology residency programs	<ul style="list-style-type: none"> This topic is about residency programs in nephrology, with a focus on various universities and medical centers across the United States. The attitude toward nephrology in this topic is positive, as evidenced by the interest and participation of individuals in the discussion.
7	Congratulatory wishes for career success.	<ul style="list-style-type: none"> Expresses congratulations and well wishes for a successful career. The documents highlight the anticipation and hope for matching with preferred places and the desire to keep in touch after the match. The topic also emphasizes the awareness of career risks and the promise of a lucrative career.

CKD, chronic kidney disease; HD, hemodialysis; ICU, intensive care unit; IMGs, international medical graduates; MUSC, Medical University of South Carolina; PCCM, Pulmonary and Critical Care Medicine; SOAP, Supplemental Offer and Acceptance Program; UAB, University of Alabama at Birmingham; UCSF, University of California, San Francisco.

Sentiment Analysis

Among 1946 posts, 88 (4.5%) were labeled as “positive,” 772 (39.7%) as “negative,” and 1086 (55.8%) as “neutral/mixed.” Our sentiment analysis model yielded good performance for identifying “negative” posts (precision 0.91 and recall 0.87) but performed poorly for “positive” posts (precision 0.39 and recall 0.5).

Subgroup Analysis

We then conducted the subgroup analysis by posts before and after 2016, the time where nephrology fellowship fill rates changed and there were more spots than applicants. BERTopic identified 11 topics from 591 posts between 2004 and 2016, and 26 topics from 1355 posts between 2017 and 2022. In [Supplementary Tables S2 and S3](#), we display the topic labels and descriptions generated by ChatGPT between 2004 to 2016 and 2017 to 2022, respectively. Posts from 2004 to 2016 were notable for mixed attitudes regarding competitiveness, lifestyle, reimbursement, and job market. Posts from 2017 to 2022 were overall more negative with concerns for workload, financial reimbursement, and job market. Positive sentiments regarding academic practice were present in both time periods. Topics of exploitation and burnout were unique to posts from 2017 to 2022.

When conducting sentiment analysis by manual review on posts before and after 2016, a higher percentage of posts after 2016 were labeled as negative. In posts from 2004 to 2016, 7.3% were labeled as positive and 12.2% as negative. In contrast, posts from 2017 to 2022 had 3.3% labeled as positive and 51.7% as negative ([Figure 1](#)).

DISCUSSION

In this study, we describe the numerous and diverse discussions on online public forums, dispelling the notion that nephrology is an overlooked field. Discussions and contributions delved into various aspects, including fellowship training, nephrology practice, financial considerations, growth opportunities, and lifestyle challenges. However, most posts expressed a predominantly unfavorable perception of nephrology. Notably, there was a shift from mixed reviews about nephrology to more negative reviews in posts before and after 2016.

Most of the topics align with the main factors that influence internal medicine residents when deciding on their specialty, as discussed in previous literature.⁵⁻⁷ Interestingly, with the nature of online platforms, we have encountered diverse ideas on both sides, depending on individuals’ experiences. This includes

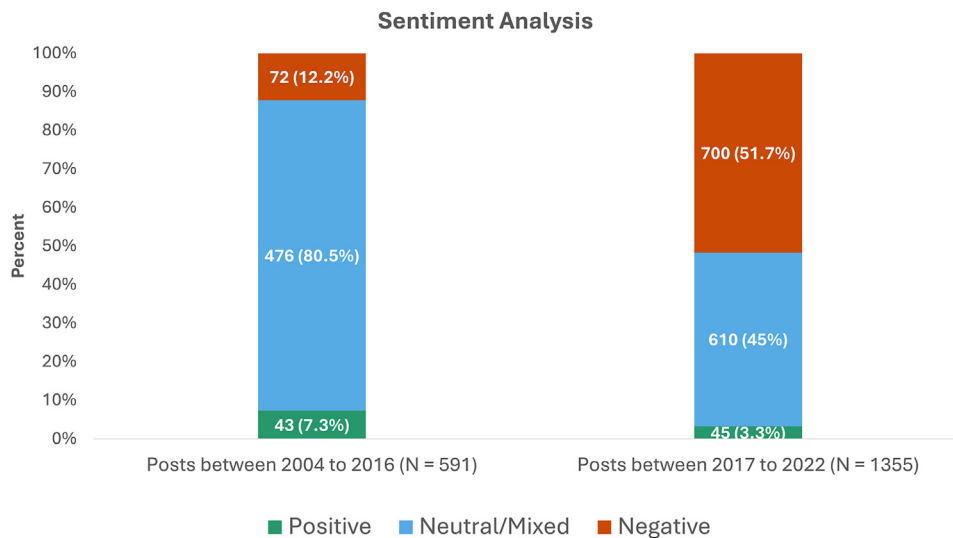


Figure 1. Sentiment analysis.

both positive and negative comments about their fellowship programs. The pros and cons of working in both academic and nonacademic settings have been widely discussed. We have also uncovered perspectives that were previously unaddressed in surveys.^{6,7} For example, discussing nephrology might be seen as an alternative route for candidates interested in critical care medicine, an area characterized by intense competition. Posts highlighted opportunities in the field of kidney transplantation. In addition, certain opinions have shed light on adverse narratives in real-life nephrology, extending beyond financial challenges to encompass issues such as a lack of transparency within the field, unequal income distribution, and instances of exploitation by senior partners. Some posts actively discourage pursuing a nephrology fellowship, as seen in statements such as “do not scramble into nephrology” or “reasons not to go into nephrology.”

Sentiment analysis shows that negative discussion has been growing recently. The attitude towards nephrology workload and salary was mainly neutral or mixed before 2016 but generally negative after 2016. There have been new discussions about oversupply of nephrologists, saturated dialysis units, and lack of growth opportunities for newly graduated nephrologists, which supports the decline of interest in nephrology applications over the past several years.

With the powerful influence of social media and its tremendous growth, directing attention toward social media and online platforms might have a noteworthy effect on enhancing the perception of nephrology and making it more appealing for trainees.^{8,9} A comprehensive standardized survey from national societies regarding job satisfaction, workload, and incomes for nephrologists could be beneficial as a publicly reliable

source that residents can refer to when seeking information to choose a subspecialty.

To the best of our knowledge, this is the first study to comprehensively analyze subspecialty-related discussions from public forums, distilling them into distinct topics using natural language processing techniques. The combination of BERTopic and ChatGPT facilitated the automatic detection and summarization of underlying topics in nephrology-related forum posts.

There are some limitations to our study. First, our study focused solely on 1 public platform. Second, because student doctor network provides anonymous posting, we were unable to determine the characteristics of the posters. Lastly, there is no existing data to compare the prevalence of positive or negative topics or posts in other subspecialties to the results of sentiment analysis in our study, which observed a negative result for 40% of nephrology posts. Exploring perceptions in other subspecialties is necessary for a more thorough interpretation of the findings.

In conclusion, we described topics posted on social media regarding nephrology training and highlighted changes in the posts over time. Measures to address concerns raised on social media may improve interest in nephrology.

DISCLOSURE

GNN is a founder of Renalytix, Pensieve, Verici and provides consultancy services to AstraZeneca, Reata, Renalytix, Siemens Healthineer, and Variant Bio; serves as a scientific advisory board member for Renalytix and Pensieve. He also has equity in Renalytix, Pensieve and Verici. LC is a consultant for Vifor Pharma INC and has received an honorarium from Fresenius Medical Care. All the authors declared no competing interests.

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DATA AVAILABILITY STATEMENT

All data are included in the manuscript and/or supporting information.

AUTHOR CONTRIBUTIONS

LC conceptualized the project. YD, AS, MB, RE, and CLC conducted data curation. KT and YD conducted the data analysis. YD and LC worked on the methodology. KT and YD worked on the visualization. KT and YD wrote the original draft. KT, YD, AS, MB, RE, CLC, GNN and LC did the review and editing.

SUPPLEMENTARY MATERIAL

[Supplementary File \(PDF\)](#)

Supplementary Methods.

Figure S1. Overview of BERTopic.

Figure S2. ChatGPT prompts.

Figure S3. Number of posts on student doctor networking by year.

Figure S4. 2D Uniform Manifold Approximation and Projection (UMAP) topic representation.

Table S1. The topic keywords generated by BERTopic and the topic labels generated by ChatGPT.

Table S2. The topic labels generated by ChatGPT from 2004 to 2016.

Table S3. The topic labels generated by ChatGPT from 2017 to 2022.

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