Primary Care Physician Education in Unified Airway Disease: A Survey Study Identifying Common Practices in British Columbia

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November 20, 2024

Abstract

Unified Airway Disease (UAD) is a disease in which patients experience both Chronic Rhinosinusitis (CRS) and Asthma simultaneously. The present study is a cross-sectional survey aiming to identify Primary Care Physicians' (PCPs) common practice patterns when caring for UAD patients. Exploratory data analysis is recommended to characterize patterns of rank agreement between PCPs and specialists. A simple diagnostic is suggested to determine if a PCP has a significant disagreement with the specialists. Regression models are recommended to identify PCP factors associated with the rank agreement.

1. Introduction

Unified Airway Disease (UAD) is a complex inflammatory condition in which patients experience both Chronic Rhinosinusitis (CRS) and Asthma simultaneously. Proper care of patients with UAD depends on adequate education of Primary Care Physicians (PCPs), who treat these patients and often refer them to specialized physicians. Thus, understanding the general practice patterns of PCPs in treating UAD can help improve PCP education, which in turn would improve UAD's treatment practice. The objective of this project is twofold: (1) to quantify the ranking correlation/agreement between PCPs and specialists, and (2) to investigate factors associated with correlation/agreement. The study is also interested in the frequency of patient referrals – i.e., how often PCPs miss necessary referrals (based on specialist assessment) and how often PCPs referrals are unnecessary. In the sections below, the current dataset is described, the relevant statistical questions are formulated, and the recommended statistical methods are outlined.

2. Data description and collection

A survey with five hypothetical patient cases was sent to PCPs in British Columbia. The PCPs were asked to each rank five to ten actions for each case in decreasing order of priority (e.g., prescribe antibiotics, refer to a specialist, and order specific test). The same survey was sent to three specialized physicians in otolaryngology, allergy and respirology, and responses from each of them were taken as a reference. The rankings from each PCP and each specialist were recorded in a spreadsheet. Missing responses were found in some patient cases, especially case five, likely due to survey fatigue (patient cases were presented in the same order throughout). PCP characteristics were recorded as covariates, including years of experience and the number of UAD patients the PCP had seen per week. Currently, 38 primary care physicians (PCPs) have completed the survey. This is from a literature-based target sample size of 60 PCPs. No missing values for covariates have been observed to date.

3. Statistical questions

The main statistical questions are as follows:

1. How can the agreement between PCPs's rankings and those from the specialists be quantified?

2. How can the association between the PCPs' characteristics and the agreement be investigated?

Secondary questions include how often PCPs miss necessary referrals or refer unnecessarily. How to handle missing responses is also of interest.

4. Exploratory Data Analysis (EDA)

To address the statistical questions, survey responses have to be summarized by calculating some agreement metric between all pairs of PCPs and specialist physicians. Once survey responses have been summarized, Exploratory data analysis (EDA) can provide a global description of the patterns of agreement between PCPs and specialists. For example, a bar chart can display how often PCPs match specialists' top rankings across five patient cases, as shown in Figure 1 below. Suppose the bar heights steadily decrease from left to right. In that case, this suggests stronger agreement between PCPs and specialist physicians on higher-priority actions, with less agreement on lower-priority actions. A similar plot can be constructed for each specialist physician.

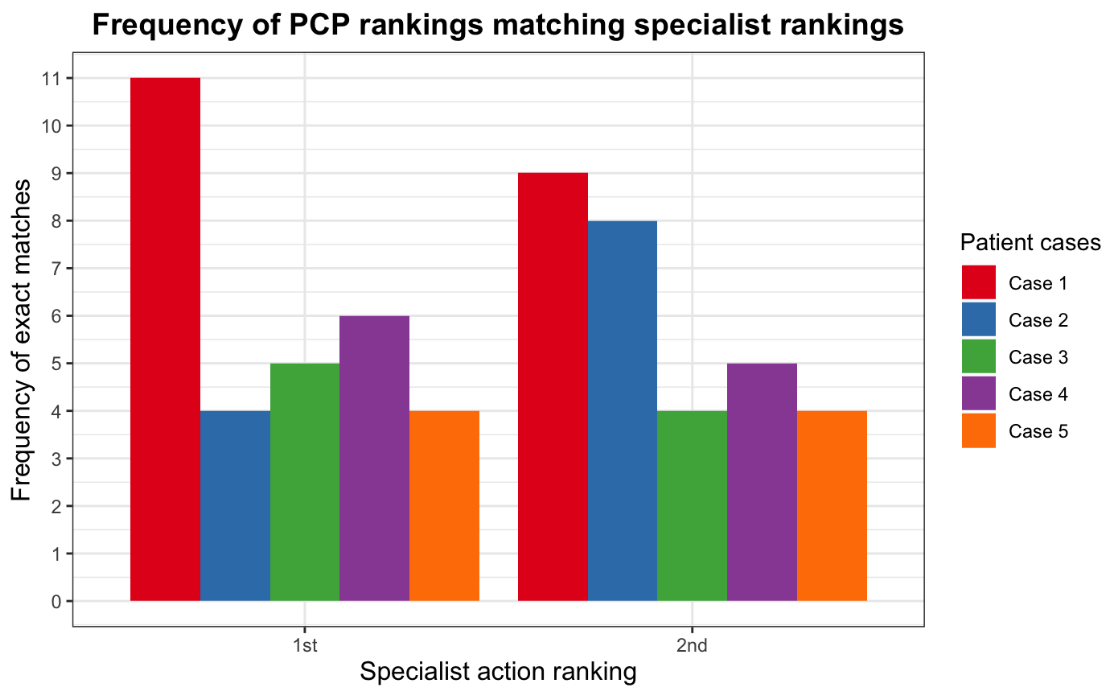

Figure 1: *An example plot for PCP - specialist physicians ranking for 30 PCPs matches. At each ranking position, five bars represent the five cases – initial and four follow-ups. Each bar indicates the frequency with which PCPs match the specialist's ranking at that position in each follow-up case.*

Additionally, a rank correlation heatmap stratified by patient case is recommended, as illustrated in Figure 2 (see Appendix for an example R code). A similar heatmap could be produced to visualize the correlations between the specialist physicians. This heatmap may help identify general correlation trends as well as trends related to missing responses.

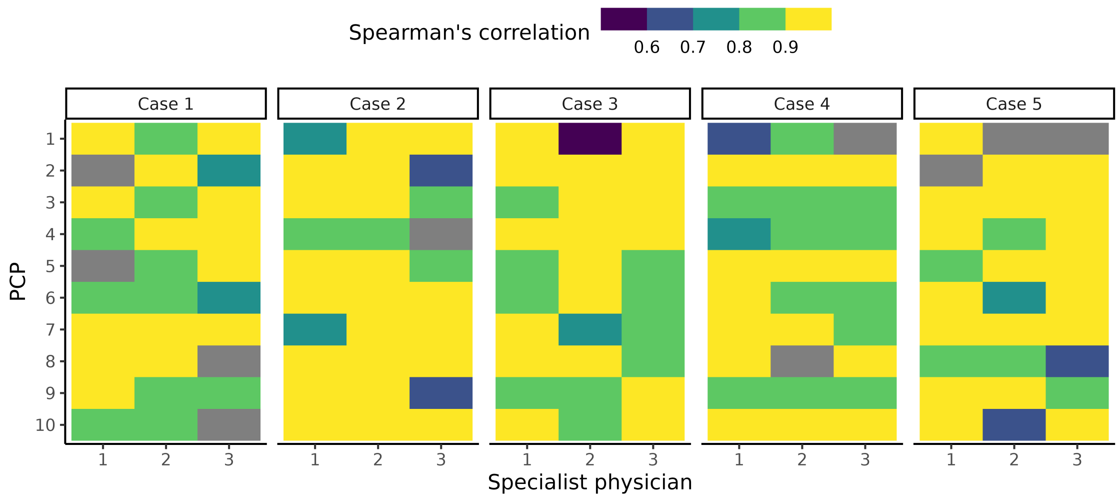

Figure 2: *Illustrative heatmap showing pairwise correlations between PCPs and specialist physicians. Correlation values are randomly generated for illustration only. Gray tiles represent missing correlation values due to missing responses.*

5. Statistical methods

For simplicity, we recommend measuring agreement using a rank correlation metric such as Spearman's ρ (rho), calculated between each PCP and each specialist, within each patient case. Because ρ gives the same weight to each ranking item, we recommend computing these metrics using all ranked actions as well as using only the top five actions as a pragmatic way of focusing on top rankings. Qualitative summaries may also be computed, such as how often a specialist's top-ranked action is among, say, the top two or three ranked actions of the corresponding PCP. It is also recommended to use the minimum between-specialist agreement (the lowest of all the rank correlation values between the pairs of specialist physicians) as a measure of a reasonably achievable agreement level. A PCP is then considered to have an educational gap if his or her overall average agreement with the three specialists across all patient cases is lower than the lowest between-specialist agreement. One may also use the median instead of the average to avoid large effects of outliers. Such an overall PCP-level summary of rank correlation values excludes missing responses under the Missing Completely at Random (MCAR) assumption. Then an estimate of the percentage of PCPs with an educational gap can be obtained.

To understand factors that affect the agreement level, it is recommended to employ ordinal regression models with the average (or median) rank correlation, converted to an ordinal categorical variable for each PCP as the outcome. These models are a suitable choice because of the bounded distribution of the outcome (between -1 and 1), potentially with many tied values. The `rms` R package contains the `orm()` function, which was specifically developed for continuous outcomes – see the Further Reading section. One model can be fitted for each variable of interest (e.g., PCP's years of experience, number of patients seen per week), using a likelihood ratio test to assess statistical significance.

Additionally, logistic regression models are recommended to investigate associations between PCP characteristics and the frequency of educational gaps (i.e., the proportion of PCPs whose average/median rank correlation is lower than the lowest between-specialist rank correlation). In this case, each PCP is classified as having an educational gap or not, and this binary outcome is used to fit one logistic regression model for each variable of interest. Again, likelihood ratio tests can be used to assess statistical significance.

Conclusions

The current study is well-positioned to characterize the agreement between PCPs and specialists regarding UAD management in British Columbia. EDA based on frequency bar plots and rank correlation heatmaps are recommended to explore general patterns. Ordinal and logistic regression models are recommended for identifying factors that affect the agreement level.

Further reading

1. Online resources about the `rms` R package [1, 2].
2. The `orm()` function from the `rms` R package [3].
3. The `ordinal` R package for another way of running ordinal regression in R [4].

References

[1] Frank E Harrell Jr. rms: Regression modeling strategies, September 2009. URL http://dx.doi.org/10.32614/CRAN.package.rms.

[2] Frank E Harrell Jr. Regression Modeling Strategies — hbiostat.org. https://hbiostat.org/rmsc/, 2024. [Accessed 10-11-2024].

[3] R: Ordinal Regression Model — search.r-project.org. https://search.r-project.org/CRAN/refmans/rms/html/orm.html, 2024. [Accessed 11-11-2024].

[4] Rune Haubo Bojesen Christensen. ordinal: Regression models for ordinal data, March 2010. URL http://dx.doi.org/10.32614/CRAN.package.ordinal.

Appendix – R code

Example of a heatmap with pairwise correlations using simulated data.

```r
# Reproduce Figure 2
library(tidyverse)
d <- expand.grid(pcp_id = 1:10, specialist_id = 1:3, patient_case = 1:5)
set.seed(42)
d$spearman <- rbeta(nrow(d), 10, 1)      # simulate random Spearman correlations
d$spearman[sample(1:nrow(d), 10)] <- NA # simulate missing responses

## make plot
p <- d %>%
    ggplot(
        aes(y=forcats::fct_rev(factor(pcp_id)), x=factor(specialist_id))
    )
    geom_tile(aes(fill = spearman)) +
    facet_wrap(~paste0("Case ", patient_case), ncol=5) +
    labs(
        x = "Specialist physician",
        y = "PCP",
        fill = "Spearman's correlation"
    )
    theme_classic(base_size = 16) +
    theme(
        legend.key.width = unit(1.25, "cm"),
        legend.position = "top"
    ) +
    scale_fill_viridis_b()
## save plot as .png file
ggsave(
    filename = "pcp_vs_specialists.png",
    plot = p,
    width = 12,
    height = 5.5,
    dpi = 600
)
```