

Exploring Medicare Costs using Machine Learning

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Summary

As various forms of technology become more ubiquitous in the field of health care, an enormous amount of data is being collected in hope of making new scientific discoveries and reforming the way we understand health care as a society. Specifically, data mining has opened up a portal to discovery and comprehension of otherwise meaningless information. Preprocessing and cleaning techniques, advanced machine learning algorithms, and data visualization tools can be of extraordinary use when trying to make sense of the vast amount of health information at our fingertips. One area of health care that is always undergoing reform and debate is Medicare. I decided to analyze inpatient Medicare coverage data in R for the years 2011 through 2013 to get a better idea of how Medicare dollars are being spent in recent years, how they compare to past spending rates, and what future rates may look like. I was able to determine that among the medical procedures that receive the most Medicare coverage, the top causes of death among the elderly were not included. Many other factors contribute to Medicare costs and were not explored during my research, but the data that I was able to analyze using data mining techniques provides a great deal of insight into an area of much discussion and controversy.

Methods

The methods I used for my research primarily consisted of data mining within the statistical software R. The original datasets were in CSV Excel sheet formats, consisted of over 450,000 entries, and needed much cleaning prior to information extraction. Once the datasets were standardized throughout all 3 years, I aggregated the data into sub tables that compared average covered charges, provider state, and the medical surgery covered. The final step was creating decision trees for the top 5 Medicare-covered states to see which state offers the best coverage pertaining to each diagnosis.

Results and Discussion

For 2011 – 2013, I determined that these states had the highest average amount covered for Medicare charges:

- 1) California - \$881,932,621
- 2) Florida - \$513,311,133
- 3) Texas - \$492,121,064
- 4) New Jersey - \$319,122,582
- 5) Pennsylvania - \$309,303,455

I also determined these medical procedures to have the highest Medicare coverage:

- 1) Major Small and Large Bowel Procedures
- 2) Infectious and Parasitic Diseases

Acknowledgements:

I would like to thank Dr. Guenter Tusch for his work as my advisor on this project, Dr. Timothy Born for his work as my mentor in the PSM program, and Professor Greg Wolffe for his expertise in machine learning techniques that helped clarify my data mining approach.

- 3) Respiratory System Diagnosis
- 4) Septicemia or Severe Sepsis
- 5) Major Joint Replacement

Although each decision tree determined that states varied in the amount of coverage for the top 5 medical procedures mentioned earlier, I also found that these top 5 states were also the biggest Medicare spenders in the last 20 years. However, many states, such as Nevada and Alaska, have increased their spending by over 10% in the past 20 years.

After looking at the results from my decision trees, I was curious as to what the distribution of Medicare looked like for each state based on certain demographics. For the top 3 spenders in the United States, it was found that the majority of its Medicare recipients were Caucasian, female, and above the poverty line. I also discovered that the top 5 causes of death among the elderly were not included entirely in the top 5 medical conditions covered by Medicare throughout 2011, 2012, and 2013. This is an extremely important finding for future research as both health care systems and politicians craft the future of Medicare in the United States. It is also important to point out that since Medicare covers half the cost, on average, these costs only represent about half of what the medical procedures actually cost throughout 2011, 2012, and 2013.

References:

1. Centers for Medicare & Medicaid Services. *Medicare Provider Utilization and Payment Data: Inpatient*. 2011 – 2013.
2. Altman, Drew; Frist, William H. (July 28, 2015). *Medicare and Medicaid at 50 Years: Perspectives of Beneficiaries, Health Care Professionals and Institutions, and Policy Makers*. JAMA 314(4): 384-395.
3. Torio CM, Andrews RM. *National Inpatient Hospital Costs: The Most Expensive Conditions by Payer, 2011*. HCUP Statistical Brief #160. Agency for Healthcare Research and Quality, Rockville, MD. August 2013.
4. Kaiser Slides, The Henry J. Kaiser Family Foundation. Facts.kff.org. Retrieved on April 3, 2016.
5. Agency for Healthcare Research and Quality, *Statistical Brief #327: Top Five Most Costly Conditions among the Elderly, Age 65 and Older*. 2008.

Case	Provider	Provider Zip	Case	Hospital Referral Center (HRC)	Discharge	Average Cost Covered	Average Total Patient	Average Meds/Supply
4491	DEFINITION		4492	DEFINITION				
4491	10001 SOUTHWEST ALMA 1508 BORN CLARK CIRCLE PROVIDER CITY	91	4492	10001 SOUTHWEST ALMA 1508 BORN CLARK CIRCLE PROVIDER CITY	91	23961.07597	277.24178	4763.79
4492	10001 SOUTHWEST ALMA 1508 BORN CLARK CIRCLE PROVIDER CITY	91	4493	10001 SOUTHWEST ALMA 1508 BORN CLARK CIRCLE PROVIDER CITY	91	336.73774	336.73774	4633.79
4493	10001 SOUTHWEST ALMA 1508 BORN CLARK CIRCLE PROVIDER CITY	91	4494	10001 SOUTHWEST ALMA 1508 BORN CLARK CIRCLE PROVIDER CITY	91	3766.375	3434.50833	4633.79
4494	10001 SOUTHWEST ALMA 1508 BORN CLARK CIRCLE PROVIDER CITY	91	4495	10001 SOUTHWEST ALMA 1508 BORN CLARK CIRCLE PROVIDER CITY	91	28	28	4633.79
4495	10001 SOUTHWEST ALMA 1508 BORN CLARK CIRCLE PROVIDER CITY	91	4496	10001 SOUTHWEST ALMA 1508 BORN CLARK CIRCLE PROVIDER CITY	91	1183.27778	560.33333	4633.79
4496	10001 SOUTHWEST ALMA 1508 BORN CLARK CIRCLE PROVIDER CITY	91	4497	10001 SOUTHWEST ALMA 1508 BORN CLARK CIRCLE PROVIDER CITY	91	802.80333	802.80333	4633.79
4497	10001 SOUTHWEST ALMA 1508 BORN CLARK CIRCLE PROVIDER CITY	91	4498	10001 SOUTHWEST ALMA 1508 BORN CLARK CIRCLE PROVIDER CITY	91	1137.1375	583.60000	4761.41
4498	10001 SOUTHWEST ALMA 1508 BORN CLARK CIRCLE PROVIDER CITY	91	4499	10001 SOUTHWEST ALMA 1508 BORN CLARK CIRCLE PROVIDER CITY	91	801.801	801.801	4761.41
4499	10001 SOUTHWEST ALMA 1508 BORN CLARK CIRCLE PROVIDER CITY	91	4500	10001 SOUTHWEST ALMA 1508 BORN CLARK CIRCLE PROVIDER CITY	91	1385.2825	1831.80535	536.79
4500	10001 SOUTHWEST ALMA 1508 BORN CLARK CIRCLE PROVIDER CITY	91	4501	10001 SOUTHWEST ALMA 1508 BORN CLARK CIRCLE PROVIDER CITY	91	544.06666	544.06666	4761.41
4501	10001 SOUTHWEST ALMA 1508 BORN CLARK CIRCLE PROVIDER CITY	91	4502	10001 SOUTHWEST ALMA 1508 BORN CLARK CIRCLE PROVIDER CITY	91	2742.52827	5841.74229	4761.41
4502	10001 SOUTHWEST ALMA 1508 BORN CLARK CIRCLE PROVIDER CITY	91	4503	10001 SOUTHWEST ALMA 1508 BORN CLARK CIRCLE PROVIDER CITY	91	550.55000	550.55000	4761.41
4503	10001 SOUTHWEST ALMA 1508 BORN CLARK CIRCLE PROVIDER CITY	91	4504	10001 SOUTHWEST ALMA 1508 BORN CLARK CIRCLE PROVIDER CITY	91	2286.23256	5374.61635	4761.41
4504	10001 SOUTHWEST ALMA 1508 BORN CLARK CIRCLE PROVIDER CITY	91	4505	10001 SOUTHWEST ALMA 1508 BORN CLARK CIRCLE PROVIDER CITY	91	346.34635	346.34635	4761.41
4505	10001 SOUTHWEST ALMA 1508 BORN CLARK CIRCLE PROVIDER CITY	91	4506	10001 SOUTHWEST ALMA 1508 BORN CLARK CIRCLE PROVIDER CITY	91	2541.33333	538.93333	4761.41
4506	10001 SOUTHWEST ALMA 1508 BORN CLARK CIRCLE PROVIDER CITY	91	4507	10001 SOUTHWEST ALMA 1508 BORN CLARK CIRCLE PROVIDER CITY	91	346.34635	346.34635	4761.41
4507	10001 SOUTHWEST ALMA 1508 BORN CLARK CIRCLE PROVIDER CITY	91	4508	10001 SOUTHWEST ALMA 1508 BORN CLARK CIRCLE PROVIDER CITY	91	1939.61835	590.11111	4772.05
4508	10001 SOUTHWEST ALMA 1508 BORN CLARK CIRCLE PROVIDER CITY	91	4509	10001 SOUTHWEST ALMA 1508 BORN CLARK CIRCLE PROVIDER CITY	91	842.84286	842.84286	4772.05
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4576	10001 SOUTHWEST ALMA 1508 BORN CLARK CIRCLE PROVIDER CITY	91	4577	10001 SOUTHWEST ALMA 1508 BORN CLARK CIRCLE PROVIDER CITY	91	1831.80535	1831.80535	4908.11
4577	10001 SOUTHWEST ALMA 1508 BORN CLARK CIRCLE PROVIDER CITY	91	4578	10001 SOUTHWEST ALMA 1508 BORN CLARK CIRCLE PROVIDER CITY	91	1831.80535	1831.80535	4908.11
4578	10001 SOUTHWEST ALMA 1508 BORN CLARK CIRCLE PROVIDER CITY	91	4579	10001 SOUTHWEST ALMA 1508 BORN CLARK CIRCLE PROVIDER CITY	91	1831.80535	1831.80535	4908.11
4579	10001 SOUTHWEST ALMA 1508 BORN CLARK CIRCLE PROVIDER CITY	91	4580	10001 SOUTHWEST ALMA 1508 BORN CLARK CIRCLE PROVIDER CITY	91	1831.80535	1831.80535	4908.11
4580	10001 SOUTHWEST ALMA 1508 BORN CLARK CIRCLE PROVIDER CITY	91	4581</					

Figure 1: Inpatient Data Example

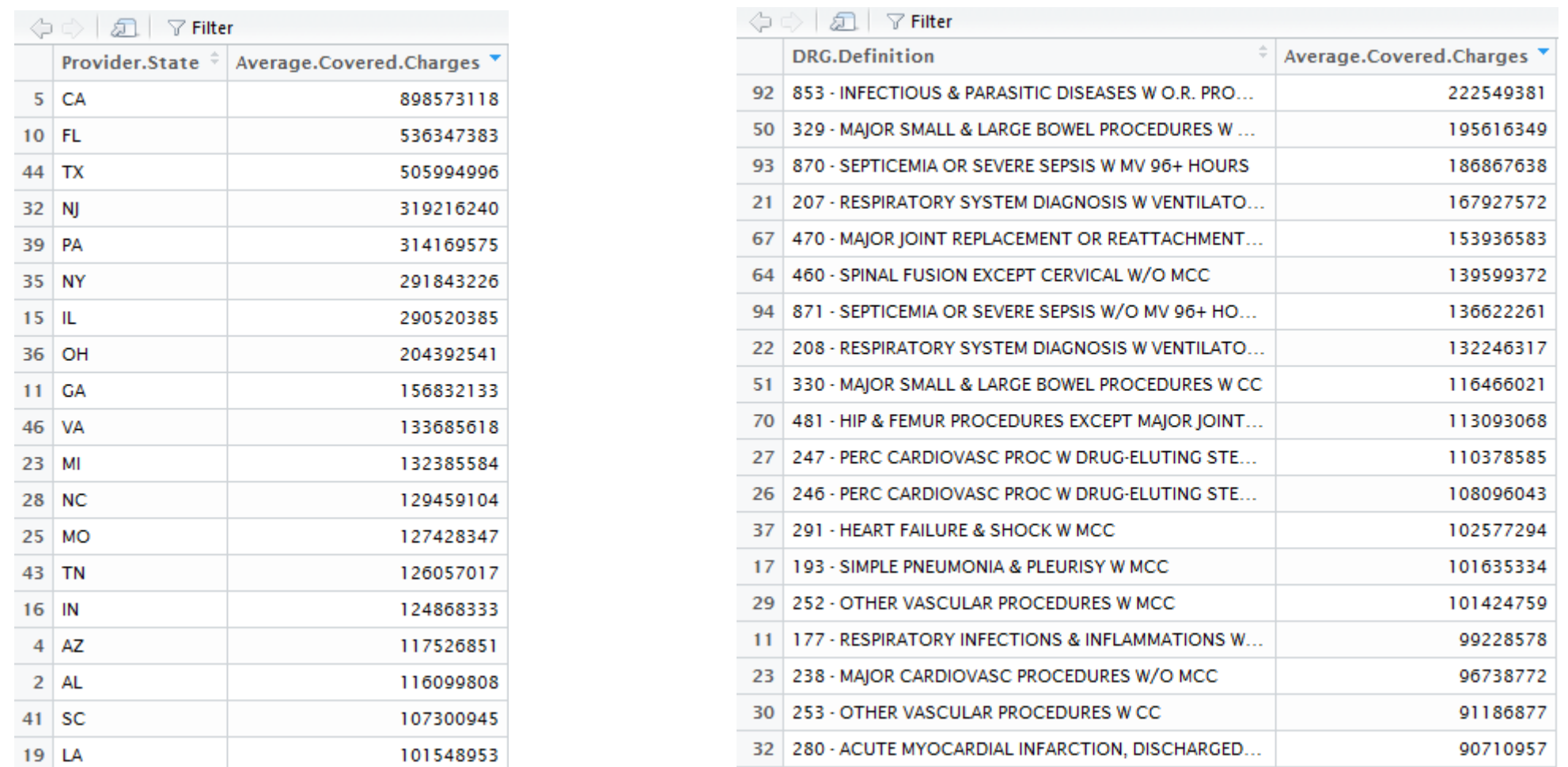


Figure 2: Data tables created in R to find top 5 states and procedures by amount covered

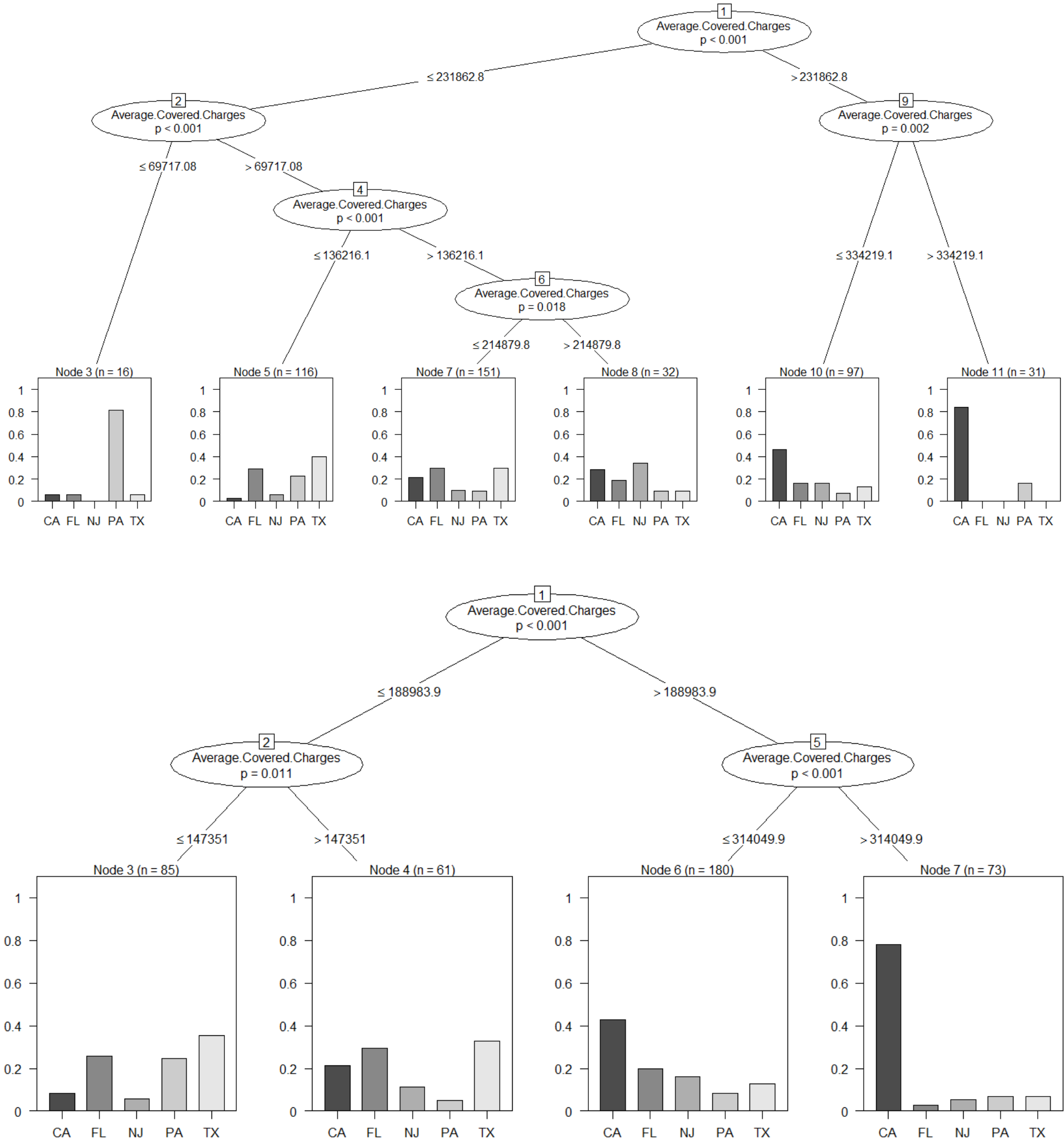


Figure 3: Decision trees for bowl procedures (2011) and infectious diseases (2012)