Identifying high cost patients in managed care: An application of fractal mathematics

Sujith Ramachandran, BS1; Kyle D. Null, PharmD, PhD2; Shannon P. Hardwick, RPh3; Judith P. Clark, RPh1

1Department of Pharmacy Administration, School of Pharmacy, University of Mississippi, University, MS, USA
2Center for Pharmaceutical Marketing & Management, University of Mississippi, University, MS, USA
3Mississippi Division of Medicaid, Jackson, MS, USA

BACKGROUND

Why did we conduct this study?
An editorial published by Fairman & Rucker in May 2009 in the Journal of Managed Care Pharmacy (JMCP) introduces the concept of fractal mathematics1 to the managed care audience and suggests the application of fractal mathematics to predict high cost beneficiaries.

The Need for a Proof of Concept in Health Care Expenditures
In the four years since publication of the Fairman & Rucker (2009) article, no efforts to apply fractal mathematics to predicting health care expenditures could be identified in the literature.

What is Fractal Mathematics?

The concept of fractal mathematics has been applied in various disciplines since Benoit Mandelbrot introduced it in the late 1970s. Mandelbrot explained that fractals are characterized by self-similarity, which is the tendency to form patterns that repeat over many orders of magnitude2.

Fractals are complicated geometric structures that observe the property of self-similarity. An object is said to display self-similarity "if it breaks down into smaller copies of itself"3. When Mandelbrot introduced the concept he demonstrated presence of fractals in naturally occurring shapes such as land masses, mountains, snow flakes etc.

In the years since then, fractal mathematics has been applied in meteorology, soil sciences, geometry, and cartography among several other fields.

In health care expenditure data, it is hypothesized that there is an 'inflection point' in the relationship between annual expenditure and frequency, indicating a significant and sudden change in the characteristics high and low cost patients. This holds the potential to lead to better understanding and prediction of health care costs1.

OBJECTIVES

The primary objectives of this study were to utilize concepts from fractal mathematics to explain health care expenditures and to identify high cost and low cost patients using the administrative claims data.

METHODS

Data source
This study used the Mississippi Medicaid fee-for-service (FFS) claims data from January 1st 2008 to December 31st 2012. All dual-eligibles were excluded from the study.

Methods
The method described by Fairman & Rucker (2009) was applied to this data. Costs incurred across the study period were pooled for each beneficiary and then the log of the cumulative number of beneficiaries was plotted against the log costs. Costs were rounded off to the nearest $1000 to aid in interpretation and to better observe an inflection point that separates low and high cost beneficiaries. Graphs were also plotted for each of the individual years in the dataset to look for repetitions in the patterns found.

Analysis
Once the inflection point was identified, the beneficiaries with an annual cost above and below the inflection point were compared on their demographics using t-tests or Chi square tests where appropriate. Both pharmacy and outpatient medical costs were included in the analysis. Inpatient medical costs were unavailable at the time of the study.

RESULTS

The graph plotted for each successive year from 2008 to 2012 and the graph plotted for overall data ranging all five years showed a similar pattern to the one shown in Figure 1 (2011).

Figure 1: Graph showing distribution of log costs versus log cumulative frequencies for 2011

An 'inflection point' might indicate a change in the characteristics of high and low cost beneficiaries.

CONCLUSIONS

• The application of fractal mathematics in the field of managed care is still in its infancy.
• The results from this study seem to convey both positive and negative aspects of the use of fractal mathematics.
• The similar pattern of results seen across multiple years (not shown) is encouraging and points towards the need for further research.

Take Away Point
Fractal mathematics has been used in more physics-driven disciplines such as soil physics, meteorology and rock mechanics. Health care does not follow known universal laws as the physical sciences.

REFERENCES


ACKNOWLEDGMENTS/DISCLOSURES

The work reported was conducted in the JMCP program in the Center for Pharmaceutical Marketing and Management as part of the retrospective drug use analysis articles conducted under contract with the Mississippi Division of Medicaid. The views expressed are those of the authors and do not necessarily reflect those of Mississippi Division of Medicaid or the University of Mississippi.