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

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Background: An editorial published by Fairman & Rucker in May 2009 in the Journal of Managed Care Pharmacy (JMCP) introduces the concept of fractal mathematics to a managed care audience and discusses its potential application in describing and explaining health care expenditures. In the four years since its publication, no other efforts have been made to apply fractal mathematics to this field. 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 magnitude. 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. An ‘inflection point’ would indicate a significant and sudden change in the characteristics of the population of high cost patients and low cost patients. This holds the potential to lead to better understanding and prediction of health care costs.

Objectives: The primary objectives of this study are to utilize concepts from fractal mathematics to explain health care expenditures. and to identify high cost and low cost patients using the Mississippi Medicaid claims data.

Methods: The method described by Fairman & Rucker (2009) was applied using Mississippi Medicaid fee-for-service data from January 1st 2008 to December 31st 2012. 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 $100 in an effort 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.

Results: The plotted graph was found to have a sharp inflection point around $5,500. The slope of the curve dipped gradually till $5,500 and dropped sharply immediately after. A similar pattern was also seen across each of the 5 years. The groups of beneficiaries lying above and below this inflection point were significantly different in age, sex and race.
Conclusions: This research holds the potential to unlock the various applications of fractal mathematics in the field of health care. A better understanding of what drives the inflection point and the differences between the groups that lie on either side of the inflection point can lead to a greater understanding of longitudinal cost growth in patients at risk for serious conditions and finally to improved prediction of future costs.