The Application of Data Mining to Evaluate the Cost-Effectiveness of Alternative Treatment Modalities in a National Medicare Database

Phoebe D. Sharkey, Loyola University Maryland, USA

Wesley Hsu, Wake Forest Baptist Medical Center, USA

Sachin Batra, Johns Hopkins Hospital, USA

Daniele Rigamonti, Johns Hopkins Hospital, USA

ABSTRACT

This paper reports on a case study applying data mining techniques to large Medicare claims databases to discover insights related to the comparative cost effectiveness of two alternative treatment modalities for treating brain tumors in the elderly. The authors evaluate the cost effectiveness of open surgery, radiosurgery, or a combination of the two. The study applies data mining algorithms including data preparation, classification, association, and predictive modeling techniques to reveal insights into the costs of alternative health care practice patterns. The results suggest radiosurgery appears to be less costly compared to surgical resection in the Medicare-eligible population. The authors also identified the fact that African Americans comprised a smaller percentage of patients receiving radiosurgery. The study demonstrates that data mining methods can be applied to large complex Medicare claims files to identify and extract undiscovered knowledge to guide medical decision making and public policy.

Keywords: African American, Cost-Effectiveness, Data Mining, Elderly, Medicare, Posterior Fossa Meningioma, Race, Radiosurgery

INTRODUCTION

Much of today’s health care debate has focused on increasing access by expanding public options, by mandating insurance requirements, and by providing subsidies for low income individuals. An additional focus of equal importance is cost containment. National health expenditures as a share of the gross domestic product continue to increase and are estimated...
to approach 20% by the year 2016 (Poisal et al., 2007). Some of this increase in health care costs can be attributed to new technologies, and it is critical that costly interventions be evaluated under the scope of health care efficacy. This pursuit has motivated an increasing interest by health care providers and payers to evaluate alternative treatment modalities with regards to cost effectiveness.

Previous research has shown the potential of applying data mining techniques to large medical datasets (Silva, Cortez, Santos, Gómez, & Neves, 2006). These techniques have been used for knowledge discovery in various types of health care applications: e.g., resource utilization for lung cancer patients (Wren, Sharkey, & Dy, 2007); patient and treatment outcomes (Delen, 2008; Delen, Walker, & Kadam, 2005; Fernandez-Breis et al., 2006; Goodwin & Iannacchione, 2006; Ohshima, Zhong, Dong, & Yoko, 2009; Shah, Kusiak, & O’Donnell, 2006); health care delivery quality (Chae, Kim, Turk, & Park, 2003; Veluswamy, 2008); development of clinical guidelines and the allocation of medical resources (Lee, Kang, & Suh, 2004; MacDowell et al., 2001); and in the identification of drug therapeutic or adverse effect associations (Bousquet, Henegar, Louet, Degoulet, & Jaulent, 2005; Kim et al., 2005; Point, Saltan, Kondaz, & Gunes, 2007).

In this research, we sought to evaluate the Medicare reimbursement data to compare the cost effectiveness of two alternative treatment approaches, open surgery and radiosurgery, for the management of brain tumors in the elderly. The Medicare population represents a major user of health care services in the United States and the claims database represents the utilization and demographic information of the health care services provided to these beneficiaries. Standard Analytical Files (SAFs) are available for inpatient, outpatient, skilled nursing facilities and home health agencies as well as for ambulatory and physician/supplier claim types (Centers for Medicare and Medicaid Services, 2010). Variables included in these files capture patient level encounter data related to diagnoses, procedures, Diagnosis Related Group (DRGs), dates and location of service, and related costs, as well as beneficiary demographic information and physician/supplier information. The unit of observation is an individual claim and multiple claims are possible for each episode of care. These files provide a powerful resource for the application of data mining techniques to compare the cost and utilization of various clinical services as well as assess the characteristics and management of specific patient populations.

Meningiomas are common intracranial tumors, and autopsy studies suggest that approximately 3% of people over 60 years of age may have an asymptomatic meningioma (Nakasu, Hirano, Shimura, & Llena, 1987). The management of these tumors continues to be debated by medical providers, and factors such as the presence of neurologic deficit, location of tumor, and tumor size/growth rate are important considerations when deciding the optimal treatment paradigm.

Traditionally, surgical resection of meningiomas has been the gold standard for tumors causing neurological deficit or exhibiting progressive growth on serial radiographic imaging. However, a younger technology, radiosurgery has played an increasing role in the management of meningiomas, particularly those that reside in areas that are of difficult surgical access. Radiosurgery may also be of benefit in patients with significant comorbidities who may not tolerate surgical resection. Skull base meningiomas usually involve critical neurovascular structures that limit the safety of complete surgical resection, (Abdel-Aziz et al., 2004) and incomplete resection of such tumors usually leads to recurrence (Marks, Whitwell, & Lye, 1986). Short-term tumor control rates using radiosurgery have been reported to be over 90% in some institutional series (Eustacchio et al., 2002; Flickinger, Kondziolka, Maitz, & Lunsford, 2003; Kobayashi, Kida, & Mori, 2001; Kondziolka, Levy, Niranjan, Flickinger, & Lunsford, 1999; Zachenhofer et al., 2006). More recent research has reported long-term tumor control using radiosurgery in both cavernous sinus meningiomas and optic nerve sheath
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