


Chapter 40

Analyzing Intraductal Papillary Mucinous Neoplasms Using Artificial Neural Network Methodologic Triangulation

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ABSTRACT

Intraductal papillary mucinous neoplasms (IPMN) are a type of mucinous pancreatic cyst. IPMN have been shown to be pre-malignant precursors to pancreatic cancer, which has an extremely high mortality rate with average survival less than 1 year. The purpose of this analysis is to utilize methodological triangulation using artificial neural networks and regression to examine the impact and effectiveness of a collection of variables believed to be predictive of malignant IPMN pathology. Results indicate that the triangulation is effective in both finding a new predictive variable and possibly reducing the number of variables needed for predicting if an IPMN is malignant or benign.

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INTRODUCTION

Pancreatic cancer is a disease with very high mortality rates (Maitra et al., 2005; Walczak & Velanovich, 2018). Unfortunately, most pancreatic cancers present as an advanced disease with survival generally less than one year (Fesinmeyer et al., 2005). Fewer patients present with early stage disease that is amenable to surgical therapy or other adjuvant therapies that can lead to longer term survival. Survival can be improved with early detection and surgery, but how can earlier detection be achieved?

Intraductal papillary mucinous neoplasms (IPMN) are a type of pancreatic tumor or cyst (D'Angelica et al., 2004). IPMN were first discovered in the early 1980's (Ohashi, 1982) and named in the 1990's (Adsay et al., 2002; Furukawa et al., 2005). Since then, IPMN have become recognized as a cystic precursor to pancreatic cystadenocarcinomas (Date et al., 2018; Lüttges et al., 2001; Maitra et al., 2005; Permuth et al., 2016). Definitive preoperative diagnosis techniques still remain elusive (Liao & Velanovich, 2007).

The research reported in this article uses methodologic triangulation using artificial neural networks (ANNs) to examine the 14 radiomic variables used by Permuth et al. (2016) to determine which variables are contributing to the estimated 77% prediction accuracy of their logistic regression model and to determine if a smaller set of variables or different variables can achieve the same or better prediction accuracy.

The next section, Background, provides an extensive background on IPMN including prevalence and consequent impact on survival for pancreatic cystadenocarcinomas. The Method section presents the methodological triangulation methodology and describes how various combinations of potential predictor variables are selected and the ANN architectures and learning methods utilized. The Results sections presents the IPMN prediction performance for all of the various triangulated ANN models developed and compares the performance of the ANN models to decision tree and regression models. The paper then concludes with a summary of the results, implications for research and practice, and recommendations for future research.

BACKGROUND

"The category of IPMN was created originally to embrace all mass-forming pre-invasive neoplasia comprising mucinous ductal cells, arising from the native pancreatic ducts" (Fernández-del Castillo & Adsay, 2010, pg. 709). The chief symptoms of individuals with IPMN are: abdominal pain, weight loss, jaundice, nausea, and fatigue and may also be concomitant with diabetes or pancreatitis (Adsay et al., 2002; Fernández-del Castillo & Adsay, 2010; Sohn et al. 2001, 2004). However, the vast majority of patients are asymptomatic and IPMN are discovered incidentally when abdominal imaging is performed for other unrelated problems (Fernández-del Castillo & Adsay, 2010; Sahora & Fernández-del Castillo, 2015). The prevalence of asymptomatic IPMN in patients has been estimated using CT and/or MRI to be from 2.6% to 27% for MD-IPMN or 83% for BD-IPMN (Laffan et al., 2008; D'Angelica et al., 2004; de Pretis et al., 2017; Pergolini et al., 2017; Salvia et al., 2004).

IPMN are typically detected using CT (computed tomography) or MR (magnetic resonance) imaging (Adsay et al., 2002; Fernández-del Castillo & Adsay, 2010; Sahora & Fernández-del Castillo, 2015). A recent research study in the USA found that IPMN occur in 2.5% of the total population over age 40, with prevalence increasing with age to over 7% and 8% in 70 year olds and 80 year olds respectively (Gardner et al., 2013). Other research, based on autopsies, estimates the prevalence of IPMN at 3.4% of the total population (Tanaka et al., 2006).

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