Novel Approaches to Predictive Modeling for Customizing Educational Activities

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INTRODUCTION

Think about it…

If an activity was successful in changing HCP behavior, do we know why?

If an activity was not successful, what may be the barrier or reason preventing improvements?

An essential component of improving patient outcomes through medical education is ensuring healthcare providers (HCPs) perform according to best practices. Traditional statistical comparisons of pre- versus post-activity performance are important for demonstrating performance improvement. However, they do not provide information regarding the factors that influence practice behaviors; if an activity was successful in changing HCP behavior, do we know why? Conversely, if an activity was not successful, what may be the barrier or reason preventing improvements?

Understanding what influences these improvements or lack thereof can help us develop future activities that continue what was successful or make necessary changes in our processes. Both scenarios can result in maximally effective educational activities which will ultimately improve patient outcomes.

PredictCME is CME Outfitters' exclusive method for applying a predictive modeling technique, known as CHAID (chi-square automatic interaction detection),[1] to our educational activities. This presentation provides results from a *PredictCME* analysis of behavior data from an educational activity on Alzheimer's disease (AD). **The model showed that the strongest predictor of behavior was confidence, with a secondary predictor being number of patients seen with AD.**

BACKGROUND

A Brief Primer on Prediction

Predictive modeling is frequently used in various research settings, but it is rarely used in medical education. Predictive modeling encompasses a variety of procedures, the most common of which is regression. In most cases, prediction involves predicting values of a "response" or "criterion" variable from the values of one or more "predictor" variables. Linear regression is used when predictor and response variables are continuous (e.g., age, weight) and logistic regression is used for response variables that are categorical (e.g., correct/incorrect).

Both linear and logistic regression are commonly used in statistics, and both have their strengths. However, among some of their limitations are flexibility and interpretability.

CHAID/*PredictCME*

CHAID is a form of predictive modeling, often used in data mining, which can be used for both continuous and categorical data. Output is in the form of a classification (or decision) tree, which provides a visual representation of the interplay between predictor and response variables, as well as how the variable categories are broken down. *PredictCME* is CME Outfitters' exclusive method for applying CHAID to our educational activities, so that we design future activities with a scientific basis for what impacts performance. Results from *PredictCME* will help guide needs assessments and ensure the appropriate topics, formats, questions, and audiences are targeted.

In addition to predicting factors that influence performance, *PredictCME* can be used for determining which variables most impact knowledge, confidence, competence, or other endpoints. It should also be noted that predictive modeling is used for data from a single time point or change score rather than comparing data from two or more time points. Table 1 outlines the possible outcomes survey time points and corresponding response variables to consider when performing predictive modeling.

Table 1. Outcomes Survey Time Points and Corresponding Response Variables for Predictive Modeling.

Time Point	Possible Response Variables
Pre-survey (participants)	*Existing* knowledge, confidence, competence, behavior
Post-survey (participants)	*Immediate* post-activity knowledge, confidence, competence, planned behavior
Follow-up survey (participants)	*Longer-term* knowledge, confidence, competence, behavior
Follow-up survey (controls)	Similar to pre-survey
Change scores (matched participants; pre/post, pre/follow-up, post/follow-up)	*Changes* in knowledge, confidence, competence, behavior

METHODS

An outcomes survey consisting of knowledge, confidence, and behavior questions was administered to HCP participants in an educational activity on AD before, immediately following, and 3 months following the activity. A separate evaluation survey was also administered immediately following the activity, which provided demographics and other variables used in the model.

METHODS *cont.*

Data from the following behavior question were used as the response variable in the *PredictCME* analysis:

In what percentage of your patients over 60 have you utilized biomarkers and imaging in the diagnosis and early intervention of AD?

0%, 1% to 25%, 26% to 50%, 51% to 75%, 76% to 100%

The following predictor variables* were entered into the model:

- Specialty
- #Years in practice
- #Patients with AD seen/month
- Self-reported competence in diagnosing or treating AD
- Confidence discussing emerging science and therapies with colleagues
- Knowledge for treatments, imaging, neurocognitive tests, cognitive domains
- Commitments to change
- Various subjective evaluation questions

*Predictor variables were selected based on expert assessments on which would most likely influence behavior and which variables would be of most interest. As CME Outfitters is the first provider to utilize this technique in medical education, there are currently no established algorithms or references guiding variable selection. We are in the process of developing such guidelines. In addition, although not available for this activity, data from questions related to practice barriers would be an important component of predictive models, which we will be incorporating in future *PredictCME* analyses.

RESULTS

Data from 262 HCPs were included in the analysis. Figure 1 shows the breakdown of academic degrees and years in practice of the participants.

Figure 1. Distribution of Academic Degrees and Years in Practice for HCP Participants in an Educational Activity on Alzheimer's Disease.

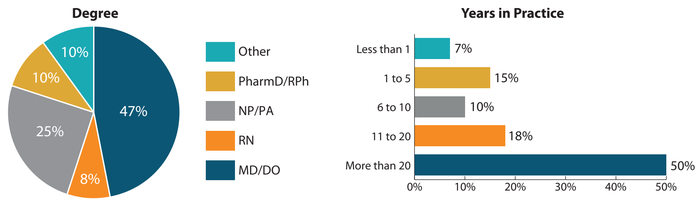


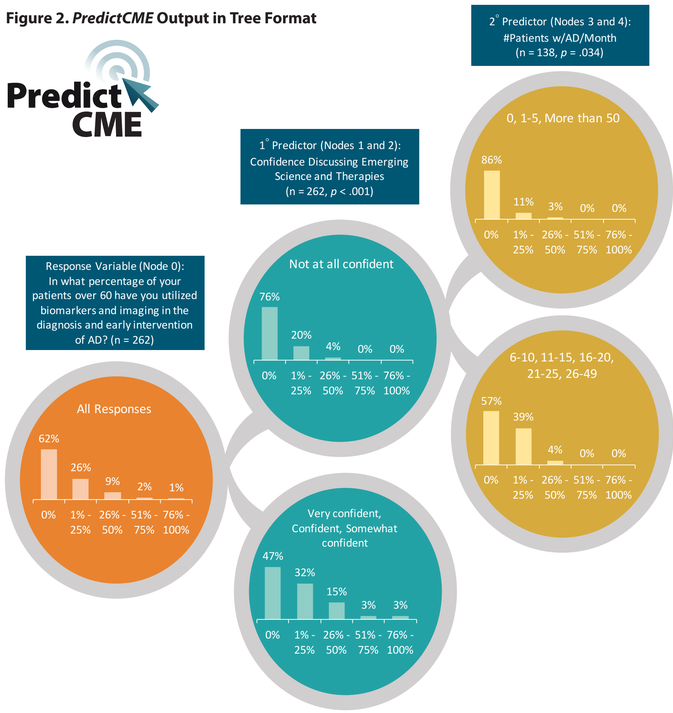
Figure 2 (next column) shows the *PredictCME* output in tree format. All graphs in the output reflect percentages of participants responding to each option in the question (0% of patients, 1% - 25% of patients, etc.). For ease of interpretation, we will focus on the percentages for "0%" (or 0% of patients), which is interpreted as "Never utilizing biomarkers and imaging in the diagnosis and early intervention of AD."

Interpretation of the output would be as follows:

1. Overall, 62% of participants indicated they never utilized biomarkers and imaging (left-most graph, node 0).
2. The primary, or strongest, predictor of utilizing biomarkers and imaging was confidence in discussing emerging science and therapies with colleagues ($p = .0001$).
   a. Fewer HCPs who expressed at least some confidence never utilized biomarkers and imaging compared to those with no confidence (middle graphs, nodes 1 and 2).
   b. Explained another way, more HCPs with at least some confidence utilized biomarkers/imaging than those with no confidence.
3. A secondary predictor was the number of patients with AD seen per month. However, this predictor only applied to HCPs with no confidence (thereby demonstrating an interaction in the model) ($p = .034$).
   a. HCPs seeing very few or very large number of AD patients were less likely to utilize biomarkers/imaging compared to those who see a mid-range number of AD patients (86% versus 57% of HCPs said 0% patients, respectively) (right-most graphs, nodes 3 and 4).

RESULTS *cont.*

Figure 2. *PredictCME* Output in Tree Format



DISCUSSION

- Results from the *PredictCME* analysis were not surprising, as studies found confidence to influence behavior.[2] In addition, previous analyses using CHAID also found confidence to be the strongest predictor of behavior in medical education activities (data on file).
- The finding that number of patients seen with AD was a secondary predictor for HCPs who were not confident was also not surprising; one would expect that an HCP seeing few patients would have less confidence, which would translate to lower likelihood of performing certain behaviors.
- What may be somewhat surprising is that HCPs seeing the largest number of patients were also less likely to perform this behavior. One possible explanation is that this may reflect a practical barrier in that there simply isn't enough time for these HCPs to perform certain behaviors, which would also be reflected in low confidence.

The findings from this study are currently being integrated into our planning for future *PredictCME* analyses as well as educational activities:

- As this study involved a single activity and therapeutic area, additional *PredictCME* analyses are currently underway for both individual activities and a meta-analysis format, examining different formats, audiences, and therapeutic areas.
- For future activities, the findings reported here are being used to evaluate ways to improve HCP confidence, address the needs of HCPs who don't see a large number of patients with AD, and address barriers of HCPs whose sheer volume of patients may impede their ability to make meaningful changes to their practices.

CONCLUSION

These findings from the *PredictCME* analysis demonstrate the utility in using predictive modeling to better understand the influences of practice behavior. We prefer CHAID to regression, as the procedure is more flexible, and the output is more intuitive and informative. It is our hope that other medical education providers will utilize predictive modeling, in its various forms, to help determine the factors that help or hinder the success of their educational activities, which in turn will help maximize the impact of future activities, and ultimately patient outcomes.

REFERENCES

1. Kass, G. V. An exploratory technique for investigating large quantities of categorical data. *Applied Statistics.* 1980;29(2):119-127.
2. Bandura A. Self-efficacy: toward a unifying theory of behavioral change. *Psychol Rev.* 1977;84:191-215.

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