



Pathology/Biology Section - 2016

H74 **Chi-Squared Automatic Interaction Detection (CHAID) Analysis as a Technique for Discerning Patterns of Drug Use in Postmortem Toxicology**

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After attending this presentation, attendees will understand how a statistical technique, CHAID, can help discern drug use patterns and their effect on drug-related mortality in a death investigation setting. CHAID analysis is one of several decision-tree methods used to explore data and identify retrospective as well as predictive patterns. It has been used for data analysis in other medical fields.

This presentation will impact the forensic science community by helping find patterns of drug use in postmortem toxicology that are not evident in any other way. Recurrent analysis of toxicology data with CHAID may also assist in identifying changing patterns of drug use in a community.

Another aspect of these deaths is that there are no well-defined criteria for certification. Essentially, death certification in a drug-related case is a process of elimination in which, if no pathologic changes are found, what remains is a drug concentration which may or may not have diagnostic certainty but is known to be associated with an increased risk of death. Procedures like CHAID can be used to understand patterns of death certification and discerning implicit criteria that may not be obvious from the decision-making process when looking at these deaths.

All of the deaths in the Wayne County Medical Examiner's Office from December 2011 to December 2014 with any positive drug result were reviewed (4,297 cases). There were 284 compounds in the extended drug screen used. Test results were analyzed as binomial variables (i.e., a positive or negative result). Positive results for metabolites were combined with positive results for the parent compound. All cases with a positive toxicology result were included, including homicides, accidents due to trauma, suicides, and natural deaths and were useful for comparison. Cases with an unknown cause of death were excluded (six cases).

Data analysis was done using Microsoft® Excel® and IBM® Statistical Package for the Social Sciences (SPSS); the latter was used for generating decision trees. All compounds present in ten or more cases were included as independent variables in the model input. The CHAID algorithm uses non-parametric testing of combinations of these categorical variables to create a model that best predicts the response variable. In this case, the response variable is the drug of abuse that resulted in accidental death, as determined by a forensic pathologist. To generate the tree, parent nodes must have at least 40 cases and child nodes at least 20 cases, and each must have a significant chi-squared statistic ($p < 0.5$). The algorithm also generates gain and index charts that help evaluate the nodes with the most statistically significant results for the response variable (the drug of abuse).

Results showed that a positive morphine result was the best predictor of drug abuse as a cause of death. In cases positive for morphine, the next best predictor of drug abuse was a positive result for codeine. Drug abuse cases that were positive for morphine were also more likely to be positive for either citalopram, an antidepressant, or alprazolam, a benzodiazepine. Drug abuse cases positive for codeine and morphine were also likely to be positive for citalopram. Cases negative for codeine and positive for morphine were instead associated with alprazolam. In cases negative for morphine, acetaminophen was the next best predictor for drug abuse. Acetaminophen-positive results were co-occurrent with hydrocodone-positive results and negatively associated with methadone. Hence, cases of drug abuse in which morphine was negative were more likely positive for hydrocodone and acetaminophen or methadone use.

Until now, the pattern between morphine, citalopram, and alprazolam was unknown, as well as that of acetaminophen/hydrocodone and methadone. Methadone has an increased risk of drug-related death independent of other drugs based on this data set. The co-occurrence of acetaminophen and hydrocodone was not unexpected; they are often combined as a prescription, but their statistical co-occurrence is validation of the power of this analytical approach.

CHAID analysis can help discern patterns of drug use that were not previously apparent. Although currently in evaluation, it is likely that recurrent CHAID analysis of drugs in these deaths can help assess changing patterns of mortality associated with drug use.

Postmortem Toxicology, CHAID, Drug Abuse