The effect of a “one for the road” drink of hard liquor, beer or wine on peak breath alcohol concentration in a social drinking environment with food consumption

Martin H. Breen, M.S., Qui T. Dang, M.S., Joseph T. Jaing, B.S.,
Greta N. Boyd,
Orange County Sheriff-Coroner’s Department, California
Forensic Science Services

INTRODUCTION

Even though it is a traffic violation to drive a motor vehicle with a blood alcohol concentration (BAC) of 0.08% or higher; there are over 20,000 individuals who are arrested every year for this violation in Orange County, California. The majority of these drivers consume different types of alcoholic beverages including hard liquor, beer, and wine from a bar or a party over a period of a few hours and with dinner or a snack.

Expert witnesses testifying in driving under the influence of alcohol cases are often asked in court to back-extrapolate the driver’s BAC at the time of the traffic stop by using the known result of a blood, breath or urine test administered one or two hours after the incident. Since BAC is a function of time, the driver’s BAC at the time of driving could be lower than the BAC at the time of the chemical test. This rising BAC (Jones, 1990) is often seen in drivers who have a “one for the road” drink just before they are pulled over by a police officer on the suspicion of driving under the influence of alcohol. In order to properly calculate the driver’s BAC at the time of driving (M.J. Lewis, 1986; K.O. Lewis 1987; Dubowski, 1985; Jones, 1988), detailed information such as the driver’s drinking pattern, the type of alcoholic beverage consumed, and the presence or absence of food in the driver’s stomach (Jones, 1991; Holt, 1981; Rose, 1979; Wilkinson, 1977) must be taken into consideration. Although there are studies reporting that the majority of alcohol is absorbed quickly (Gullberg, 1982) even when it is consumed together with a large meal (Jones and Neri, 1991), no previous study has reported the absorption and distribution of the “one for the road” drink.

The purpose of this series of studies is to examine the maximum increase in breath alcohol concentration and the time it takes to reach the peak after finishing the “one for the road” drink. The same individuals consumed hard liquor, beer or wine on three separate occasions in a social
environment with food.

METHOD

Subjects and conditions
Thirteen healthy volunteers, seven men and six women, participated in these studies and were designated as subjects A through M. They described themselves as social drinkers who consume alcohol only occasionally. The mean age of the male and female participants was 32 and 28 years old respectively. The mean body weight of the male and female participants was 164 and 134 pounds respectively. The subjects consumed hard liquor for the first study, beer for the second study and wine for the third study. Nine of thirteen subjects participated in all three studies, while the remaining subjects were able to participate in at least one or more of the studies. At the beginning of each study, the drinking subjects were required to perform a breath test showing that they were alcohol free.

All subjects ate dinners which included common food such as hot dogs, hamburgers, sandwiches, burritos, meatballs, rice, pasta, soup, salad, fruits and/or vegetables, immediately before or shortly before drinking started. Snacks were available throughout the study. The subjects were instructed to keep the same activities for Day 1 and Day 2 of each study. At the completion of the study, the subjects were driven home by designated drivers.

For each study, monitors were assigned to each subject to record relevant information such as the subjects' activities during that day, the kind of food they had for dinner, the time they had dinner, their age, sex and weight. The monitors also recorded the amount of drinks consumed, the time it took to consume the drinks, the time of the breath tests and the duplicate breath test results. Each subject was assigned to the same breath alcohol instrument in Day 1 and Day 2 of each study.

Each study consisted of two consecutive days. Day 1 served as a control in which the subjects consumed a known amount of alcohol at their own rate until their BrAC was near the 0.08% level. Chips, dip, and other snacks were available; and the subjects talked, played cards, pool, etc... with music in the background. The atmosphere was similar to that of a bar or a party. The subjects' duplicate breath samples were taken fifteen minute after finishing each drink. After the last drink, the subjects' BrACs were measured at 15-20 minute intervals for approximately four hours to establish their time to peak and their elimination rates during the post-absorptive phase.

Day 2 was a repeat of Day 1 with the addition of the “one for the road” drink.. The subjects were given a “one for the road” drink when their BrAC started to decline. The amount of alcohol for this drink was 30 to 60 milliliters of hard liquor for the first study, 355 milliliters of
beer for the second study and 177 milliliters of wine for the third study. The subjects’ BrACs were also recorded every 15-20 minutes after the final drink until the completion of the study, approximately two hours later.

The main purpose of Day 1 was to obtain a baseline curve for each subject that could later be compared with the BrAC curve of Day 2. It was to ascertain that the BrAC increase of the “one for the road” drink in Day 2 was attributed to this drink and was not affected by other biological factors. It also helped to determine the dosage, the consumption rate for each subject in Day 2; and to determine whether or not a subject could handle an alcoholic beverage other than his/her preference, so he/she could continue to Day 2.

Instrumentation
Intoxilyzer 5000 instruments, manufactured by CMI Inc., were used to measure the subjects’ BrAC. These instruments have been in use in all Orange County law enforcement agencies since 1987. Breath tests were taken in duplicate and the results must agree within 0.020%. If the two results did not agree, a third test was taken. Calibration checks were performed on each instrument before, during and after its use each evening. They were within 0.010% of the known values of the simulator solution. Air blanks between samples gave a reading of 0.000%.

Alcoholic beverages
For hard liquor, subjects consumed Smirnoff Vodka, Ronrico Rum, tequila, or Williams Bourbon Whiskey. For beer, they consumed Miller Genuine Draft, Corona or Budweiser. For wine, they consumed Mondavi Riesling, Beringer White Zinfandel, Mondavi Fume Blanc, Rutherford Cabernet, Columbia Crest Merlot, or chardonnay.

Calculations
BrACs were plotted against time to obtain the BrAC curve for each subject. Each data point represents the average of the duplicate BrACs.

Data collected from Day 1 of each study were used to calculate the time to peak after the last drink and the elimination rate of each subject.

Data collected from Day 2 in each study were used to calculate the time to peak and the BrAC change after finishing the “one for the road” drink.

Because of a 15 minute waiting period for the dissipation of mouth alcohol, the change in BrAC after the last drink is the difference between the highest BrAC and the last measurement before
the last drink. Plateaus were observed for subjects whose BrACs remained within 0.010% of the highest BrAC over time with the beginning of the plateau being the first data point within 0.010% from the highest measurement.

RESULTS

Shapes of BrAC curves:
The shape of the BrAC-time profile for most individuals followed the expected course of a rapid rise during absorption, a clear peak, and a steady fall during elimination. A typical profile is observed in Figure 1. The second peak representing the BrAC rise after finishing the “one for the road” drink is also seen in this figure. Plateau, which is the part of the BrAC curve within 0.010% from the highest point without a steady decline in BrAC over time is also observed and seems to occur more often with hard liquor or wine and is not seen in beer drinkers.

BrAC rise and time to peak after finishing the “one for the road” drink:
Eleven subjects who had 30 to 60 milliliters of hard liquor gave an average BrAC rise of 0.017% from the last measurement with a range of 0.005 to 0.034%. The average time to peak or plateau after this “one for the road” drink was 18 minutes with a range of 0 to 35 minutes. The average rise of BrAC from 9 subjects who drank 355 milliliters of beer was 0.016% from the last measurement with a range of 0.008 to 0.028%. The average time to peak or plateau after this “one for the road” beer drink was 16 minutes with a range of 15 to 20 minutes. This is comparable to an average rise of 0.016% (range of 0.007 to 0.026%) from the last measurement in a 20 minute average time (range of 15 to 45 min.) to peak again for 10 subjects who had 177 milliliters of wine “for the road.”

Time to peak or plateau after finishing the last drink:
Time to peak or to the first point of the plateau of the last drink (not the “one for the road”) does not differ significantly for hard liquor, beer or wine. The average time is 15 minutes for hard liquor, 19 to 22 minutes for beer and 23 to 24 minutes for wine. The time to peak is reproducible within 5 minutes for 9 of 11 hard liquor drinkers, for 5 of 10 beer drinkers and for 4 of 10 wine drinkers. The range of time to peak or plateau for the last drink in this study is from 0 to 35 min. for hard liquor, 15 to 40 min. for beer and 5 to 60 min. for wine.

The time to peak or plateau of the “one for the road” drink is very close to that of the last drink.

BrAC change after finishing the last drink:
The average BrAC rise from the measurement before the last drink to the peak or plateau is from 0.022% to 0.028% for all three types of alcoholic beverages. These values are higher than those of the “one for the road” drink (0.016% to 0.017%) because the last drink was consumed while
subjects were still in the absorptive phase of the BrAC curve and the “one for the road” drink was consumed in the elimination phase.

Figure 1: Typical BrAC curve of “one for the road” study (subject A, wine).

Dotted lines (day 1), last drink at 70 min.
Solid lines (day 2), last drink at 85 min., “one for the road” drink at 180 min

REFERENCES


Toxicol. 14.


