In vivo evaluation of BACtrack® Skyn: a discrete wrist-worn transdermal alcohol monitoring device marketed to the public

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Abstract

A discrete wrist-worn transdermal alcohol monitoring device, the BACtrack® Skyn, was evaluated in a subject over three drinking sessions. The relationship between transdermal alcohol concentration (TAC) and breath alcohol concentration (BrAC) was evaluated in a subject during three drinking sessions. The relationship amongst all contemporaneous TAC/BrAC measurements revealed an R^2 of 0.65, while the relationship in the post-45-minute drinking phase revealed an R^2 of 0.89. Results obtained show promise for its use. Further research is needed with many subjects in real-world drinking situations.

Introduction

In March of 2015, the National Institue of Health issued a challenge to create a "Wearable Alcohol Sensor Challenge" that could discretely measure alcohol concentrations in real-time (1). The winner of the challenge received $200,000 (USD). BACtrack® Breathalyzers (San Fransisco, CA), created a prototype of a discrete wrist-worn transdermal alcohol monitoring device, which was selected as the winner of the competition in May of 2016 (2). In September of 2019, BACtrack® Skyn was made available for research purposes (3). This study evaluated the relationship between breath alcohol (BrAC) and transder-

mal alcohol measurements recorded with the BACtrack(r) Skyn in a subject during three drinking sessions.

Continuous transdermal alcohol monitoring may be useful for self-tracking (4; 5; 6), medicine (7; 8), remote monitoring of alcohol use (9; 10), traffic safety (11), law (12), and research (13; 14). Most of the current generation of transdermal alcohol monitoring biosensors are bulky devices marketed towards criminal law enforcement monitoring of repeat alcohol-related offenses (15; 16; 17; 18; 13). More recently, discrete transdermal alcohol sensors have been developed for continuous monitoring of alcohol use (19; 20; 21; 22; 23; 24; 25; 26; 27).

Methods and Materials

The BACtrack(r) Skyn (BACtrack Breathalyzers, San Fransisco, California, USA) device contains an electrochemical fuel cell to continuously monitor alcohol vapors emanating from the skin. It records measurements every 20 seconds and transmits data via Bluetooth(r) to an app on the user's smartphone. Photos of the device are shown in figures 1 and 2.

Figure 1: BACtrack® Skyn

Figure 2: BACtrack® Skyn sensor

Contemporaneous TAC/BrAC measurements were collected in a subject during three drinking sessions. After a fast of at least 4-hours, a subject (the author) drank a mixture of orange juice and 80-proof vodka ad libitum during a 5-minute period. BrAC measurements began 15-minutes after the end of drinking to ensure residual mouth alcohol did not bias the BrAC measurements (28; 29). BrAC measurements were taken approximately every 16 minutes. Transdermal alcohol measurements were recorded every 20 seconds. A total of 43 Contemporaneous TAC/BrAC measurements were analyzed from three drinking sessions lasting 1.4, 2.0, and 8.1 hours.

An electrochemical breath alcohol analyzer, the BACtrack(r) Mobile Pro (BACtrack Breathalyzers, San Fransisco, California, USA) was used to measure BrAC (30). Accuracy checks were performed with the breath alcohol analyzer prior to use at reference vapors of 0.007, 0.065, 0.080, and 0.162 g/210L (g/dl blood alcohol [BAC] equivalent). Results fell within 0.002 g/210L of reference standards.

Results

The mean time-to-peak BrAC was 33-minutes, while the mean time-to-peak TAC was 60-minutes. The relationship between TAC/BrAC for all measurements (n=43) revealed an R^2 of 0.65. A scatterplot of the relationship is shown in figure 3. The TAC/BrAC relationship during the post-45-minute drinking phase (n=37) revealed an R^2 of 0.89. Figure 4 shows a scatterplot of the TAC/BrAC relationship in the post-45-minute drinking time period.

Figure 5 shows a line graph plotting the TAC/BrAC measurements taken over an 8 hour period.

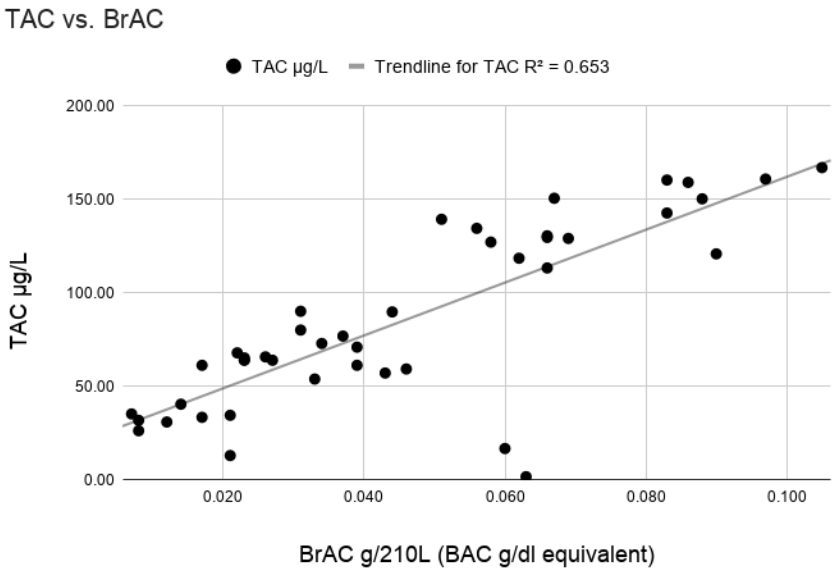

Figure 3: TAC vs. BrAC for all measurements

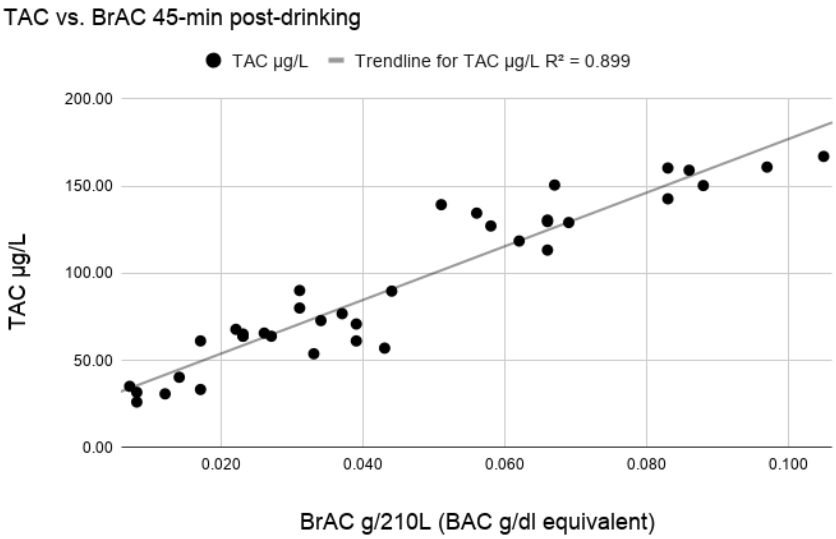

Figure 4: TAC vs. BrAC in the 45-min post-drinking time period

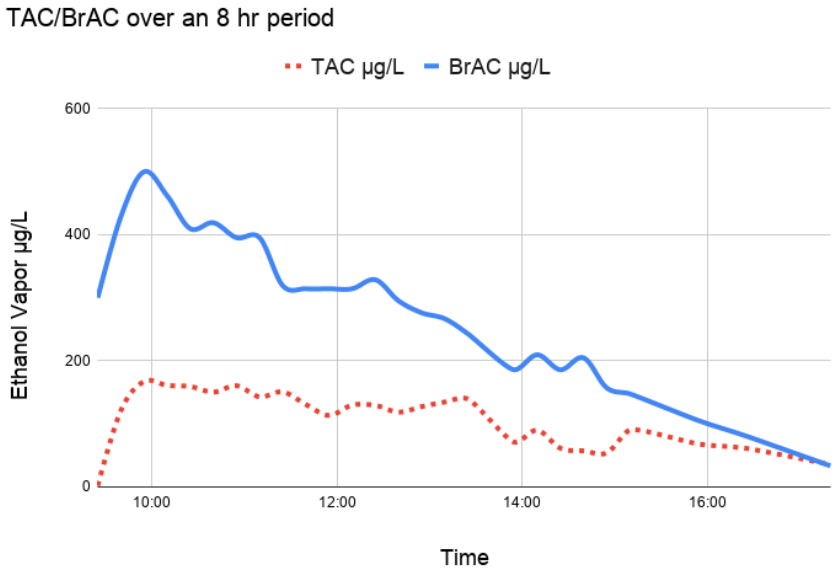

Figure 5: TAC/BrAC over an 8 hr period

Discussion

Differences in time delays in peak TAC relative to peak BrAC have been documented in the literature (31; 32), and shown to be dose-dependent (11). Time-to-peak alcohol concentration is known to vary by the matrix (33). Similar time delays have been documented in time-to-peak urine alcohol vs. time-to-peak BAC, where peak urine alcohol is obtained after peak BAC (34).

In addition to time delays, venous/arterial compartmental differences in alcohol concentration have been documented in the literature (35; 36). Venous/arterial compartmental differences can affect the ratio between BrAC to BAC during the absorptive phase of alcohol pharmacokinetics (37). This alcohol compartmental difference could affect the TAC/BrAC relationship and may explain the higher R^2 value (0.89) in the TAC/BrAC relationship during the post-45-minute drinking phase. It is also plausible that transdermal alcohol devices may be more useful when used as a screening tool, rather than a predictive measurement of BrAC or BAC (38; 39; 40).

Limitations

The scope of this study was limited to a single subject. More work needs to be done in many subjects under realistic social drinking circumstances. In addition, more research needs to be done on the effects of active perspiration through exercise, long-term fouling of the sensor (41; 42), changes in skin temperature, and the effect of topical substances such as lotions and perfumes.

Conclusions

The results obtained from the BACtrack® Skyn transdermal alcohol monitoring device show promise for its use. The relationship between TAC/BrAC was highly correlated, especially in the post-45-minute time period after drinking. Further research is needed under real-world social drinking conditions.

Conflicts of Interest

None.

Declarations

All statements and opinions are solely that of the author.

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