A NONINVASIVE, OPTICAL APPROACH for Measuring and Quantifying Blood Alcohol While Simultaneously Verifying Identity
n 2010, the Researchers found the costs resulted from losses in workplace productivity (72 percent of the total cost), health care expenses for problems caused by excessive drinking (11 percent of the total cost), law enforcement and other criminal justice expenses related to excessive alcohol consumption (9 percent of the total cost), and motor vehicle crash costs from impaired driving (6 percent of the total cost). The study did not consider a number of other costs such as those due to pain and suffering by the excessive drinker or others who were indirectly affected by the drinking, and thus may be an underestimate. Researchers estimated that excessive drinking cost $746 per person in the United States in 2006.\(^1\)

Alcohol can impact the workplace in several ways; people can show up and drink while on the job, they can be impacted by the festivities and activities of the night before, and even non-drinkers can be impacted by those consuming alcohol around them. Sadly, such scenarios are more common than people might think as over 15 percent of U.S. workers have reported being impaired by alcohol at work at least one time during the past year, and 9 percent of workers reported being hung over at work.\(^2\) In many cases, these alcohol impaired workers are valuable employees worth retaining but have simply made poor decisions before showing up to work. As a result of their poor decisions, accidents are more likely to happen despite the best implementation of company education and employee assistance programs. Furthermore, it is unlikely, in a statistical sense, that a safety-sensitive designated worker who makes a bad decision once or twice a year will be selected for a random alcohol test on a day where they are impaired. As a result, the effectiveness of many random alcohol testing programs for detecting these events is limited.

Companies are increasingly seeking novel, low cost, and easy-to-implement methods for reducing alcohol related costs in the workplace. One such method is the implementation of effective prevention and sobriety assurance programs that provide for a direct and frequent means for determining fitness to work and thereby ensure safer work environments. While several reliable alcohol testing technologies exist, widespread adoption for daily/frequent testing for deterrence and sobriety assurance programs has yet to occur. Limiting factors have included: the potential high costs for frequent testing, workflow disruption, the use of staff resources for test administration, and in some cases workforce/union resistance to the implementation of high frequency testing even of safety sensitive designated employees.

With the limitations of existing approaches in mind, TruTouch Technologies has developed and is commercializing a novel near-infrared based alcohol and biometric sensor that is noninvasive, easy to use, and self-administered. These optical devices are used as a screening tool and non negative results are typically confirmed per the existing alarm resolution policy—either locally (using a breathalyzer for example)—or results are verified externally at an accredited laboratory so that

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Figure 1—NIR spectra of water and ethanol

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Centers for Disease Control published a report indicating that the cost of excessive alcohol consumption in the United States reached $223.5 billion in 2006\(^1\). Almost three quarters of these costs were due to binge drinking, where binge drinking is defined as consuming four or more alcoholic beverages per occasion for women or five or more drinks per occasion for men. BY OSCAR LAZARO, TRUTOUCH TECHNOLOGIES
such as sunburn. The devices measure the 4000-8000 cm\(^{-1}\) (1.25-2.5 μm) spectral region, which is of prime interest for making noninvasive alcohol measurements. It offers specificity for a number of analytes, including alcohol and other organic molecules present in tissue, while allowing optical path lengths of several millimeters with acceptable absorbance characteristics. In addition this completely non-invasive approach to alcohol testing fully integrates biometric identity verification thus offering a number of significant improvements over existing methods. This unique combination makes routine, self–administered workplace testing a realistic and easy to deploy deterrence solution. From first touch to test results, the entire process can take less than 20 seconds.

An advantage of NIR spectroscopy is that the structure of a molecule dictates the specific manner in which it absorbs NIR light. Thus, the absorbance spectrum of each molecular species is unique, which allows the spectrum of alcohol to be discriminated from those of other molecules, such as water, that are commonly present in the body. Figure 1 shows the NIR spectra (normalized to unit concentration) of alcohol and water acquired from the device which demonstrates the effect of molecular structure on NIR absorption.

In addition, Beer’s Law states that the magnitude of the absorbance signal for a given substance (e.g. alcohol) is proportional to its concentration. Consequently, NIR spectroscopy provides noninvasive measurements that are both sensitive and selective for alcohol. This noninvasive alcohol measurement technology has been tested in multiple clinical studies involving over 400 participants and 10,000 alcohol measurements. The study participants spanned a wide range of demographics (e.g. age, gender, ethnicity, and body type) and environmental conditions. All studies were performed following a strict protocol approved by a hospital Institutional Review Board (IRB) to ensure the safety of the subjects and the safe use of the device.

In one such peer-reviewed study\(^3\), 26 volunteer subjects (demographics in Table 1) were measured to assess the accuracy of TruTouch and breath alcohol relative to venous blood alcohol. Subjects were consented according to an IRB-approved protocol. Alcohol doses were administered to achieve peak blood alcohol (BAC) values of 120 mg/dL (0.12 percent). Blood alcohol measurements were acquired in approximately 15-minute intervals in order to monitor alcohol concentration. Once alcohol absorption was completed (15-40 minutes from ingestion, depending on the subject) and BAC began to decline, repeated cycles of blood, breath and noninvasive alcohol measurements were acquired (~15 minutes per cycle) until the subject was below 20 mg/dL (0.02%). Three hundred and sixty sets of noninvasive, blood and breath alcohol measurements were acquired from the 26 subjects. The results (Figure 2) show a strong TruTouch-blood correlation (r=0.95) to blood chemistry (head space gas chromatography).

<table>
<thead>
<tr>
<th>Gender</th>
<th>Male</th>
<th>Female</th>
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<td># Subjects</td>
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Table 1—Study Demographics
In addition to measuring and quantifying blood alcohol, the spectroscopic measurement provides a biometric identity verification capability that prevents “buddy punching” (e.g., one person takes the test for another) and allows the systems to be used in an unsupervised manner. The underlying signal used by the biometric is predicated on the fact that each person’s skin has unique characteristics. Skin is primarily comprised of the epidermis, dermis, and subcutaneous layers and each has different characteristics that influence its relative contribution to the spectroscopic measurement. For example, the subcutaneous layer is largely comprised of lipids (fats) while the dermal layer is composed primarily of water and collagen. The TruTouch measurement inherently contains contributions from each layer, which provides insight into both the chemical composition and structure of the tissue. Because all people have different tissue properties (e.g., dermal hydration, collagen density, and layer thickness), the measurement captures these interpersonal differences and uses them as the basis for its unique biometric identity verification feature.

The impact of alcohol consumption on workplace productivity and the bottom line costs to all industries in the US and internationally have been well documented. Companies would like to reduce these costs and understand that effective routine workplace alcohol measurement can mitigate these problems. This method being cost effective and self-administered—may provide companies with yet another tool that can be integrated with existing programs to impact workforce alcohol use and increase fitness for duty across the board.

References

Cesare Lazaro is a life sciences executive with 25 years commercialization experience selling medical devices, diagnostics & analytical instruments. He has held senior roles with Serono, Hologic, Ion Track (sold to GE) and Anura Scientific (sold to Thermo Fisher). As the SVP Strategic partnering at TruTouch, he is focused on building out the global distribution channel for the company's unique product line.

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