THE SENSITIVITY AND SPECIFICITY OF INFRARED PUPILLOMETRY MEASUREMENTS IN IDENTIFYING DRUG IMPAIRMENT IN A COUNTY PROBATION PROGRAM

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Introduction:

In California, there are approximately 600,000 probationers within the criminal justice system. Drug testing is an important tool to reduce health and workplace costs and to monitor criminal offenders. Unlawful drug use is a violation of the conditions of probation and periodic drug testing is an effective method to deter and to detect drug use. Unlike most forms of misconduct, it leaves a chemical trace that can be detected reliably by relatively inexpensive tests. San Diego and Los Angeles have fairly elaborate testing programs, but neither tests more than a small proportion of its clients. [1]

Frequent testing is essential to reducing the rate of drug use. Once-a-week testing produces about a 35% chance of detecting any given incident of drug use. Industry and law enforcement, e.g., probation departments, employ drug screening to check for drug free compliance. Drug testing (urinalysis) itself is relatively low-cost, between $5 and $10 per test. However, when such testing is performed thousands of times per month, the cost may be quite costly and possibly prohibitive for an effective compliance program.

An alternative or adjunct approach may utilize newer noninvasive physiological methods that measure impairment. These may be more efficient and less costly than urinalysis. One such method is pupillometry. Alterations in pupillary reactions have been shown to be related to the presence of drugs. [2,3.4]. The use of photographic, videographic, and/or infra-red pupillometry has been employed experimentally and commercially for the detection of physiological impairment. [5-10]

If an alternative or adjunct approach, e.g., infra-red pupillometry, to measure impairment can be demonstrated to be effective, then more effective compliance in monitoring probationers may be achieved.

Purpose: The objective of this pilot program was to determine the sensitivity and specificity of a commercially available pupillometer to detect possible impairment due to drugs when compared with urinalysis.

Methods:
Subjects :
The subjects were defendants on probation with the San Diego County Dept. of Probation in San Diego County, California. Participating were one hundred forty six subjects, aged 18-50 years (Mean 34.3(10.2) years) with 72% male and

18% females . These subjects were on a frequent drug testing schedule ranging from weekly to monthly. They were tested on a random basis. Each one was given instructions to call a recorded message each night and to listen for a color, assigned to them by staff. When their color came up, they were instructed to report to the probation office for testing the next day. Each subject was tested at least once .

Method

When tested, each subject received two procedures for possible drug impairment: (1) the standard urinalysis, using the Gas Chromatography Mass Spectrum (GCMS) method to determine the presence of drugs, and (2) measurement of pupillary responses by a trained probation staff member using the MCJ Inc. Eye Check™ infrared pupillometer .

Pupillometer Procedure:
At the beginning of each test, a verbal survey was conducted. Subjects were asked several screening questions: (1) Informed consent and permission to participate in the study, (2) Had they ever suffered a serious head or eye injury, and(3) their age. Before a subject was deemed suitable for screening, personal and historical information was entered into the Eye Check™ computer program. Information entered included; identification number, probation officer's name, age, nationality and any other pertinent information, such as medications taken. When all of the information was entered, the subject was instructed to pickup the Eye Check™ Pupillometer instrument. The instrument weighs approximately 2 lbs. and is held similar to a pair of binoculars with peripheral eye shields to exclude light. **(Figure 1).** They are instructed to look into it, and focus on a red crosshair with the eye being tested. **(Figure 2)**

At the start of each test, subjects were told not to remove the instrument from their eyes until instructed to do so at the end of the test. During a thirty second adaptation to the dark, the participants were told that they would see a series of three green flashing lights with five second intervals, between each flash. The subjects were told that they could blink as needed during the dark adapt time period and between flashes. To further clarify the instructions, subjects were told that they would be instructed when to blink and not to blink. Other instructions given were; do not chew gum, do not speak and remain as still as possible during the test. The instrument and software tracks the pupil's reaction response to a light stimuli. The pupillary dynamics are collected, recorded, and stored.

Based on the proprietary algorithms in the Eye Check™ software which is measuring the initial pupil diameter, a controlled flash of light , the light reflex reaction including the time to initiate the pupil constriction, the length of time to full constriction, the final pupil diameter, and the change in pupil size from the dark to light condition, a determination of possible drug impairment vs. normal is

made. The data is then processed and the results are displayed on your computer screen. The displayed data indicates a PASS/FAIL results.

Results: The objective of this investigation was to determine the sensitivity and specificity of a commercially available pupillometer to detect possible impairment due to drugs when compared with urinalysis. In this study, the sensitivity and specificity of the Eye Check™ pupillometer in detecting potential presence of drugs was determined. The presence or absence of a pharmacological agent was confirmed with urinalysis employing a comprehensive drug screen (GMSA). The drugs identified by toxicological evaluation included marijuana, stimulants, including amphetamine, cocaine, tranquilizers, and opiates, including heroin.

Applying the positive vs. negative for impairment criteria and scores as part of the analysis software by the manufacturer, the sensitivity and specificity of the Eye Check™ pupillometer was assessed. The results were based on a total 126 subjects since approximately fourteen percent of the tests conducted on the original 146 subjects were inconclusive on the Eye Check™ due to various reasons, e.g., defendant's history of drug abuse, prescribed medications, medical conditions, and operator training. Of these, sixty-five percent were negative for drugs or impairment on the Eye Check™ Pupillometer and urine screen. Fifteen percent of the tests conducted were positive on both the Eye Check™ Pupillometer and urine screen for a variety of drugs. Seventeen percent were considered false positives on the Eye Check™ and three percent were considered false negative.
Based on this, The Eye Check™ appears to differentiate subjects who were potentially drug impaired from normal in the majority of cases. The sensitivity was 86.2% and the specificity was 78.85%.

Discussion:

It should be noted that many subjects tested were under the care of physicians and were occasionally prescribed pain and or psychotropic medications. These prescribed drugs may have impacted the results of the pupil tests. The Eye Check™ system rated these tests as positive where urine screening was designed to ruled out the presence of higher dosage level street drugs.

What was the economic and drug free compliance outcome in this study? Based upon the first five months of this fiscal year it is projected that the San Diego County Probation Department will have conducted over 48,000 urine tests. The cost of a five panel urine toxicological screening test is $6.55. The estimated total cost for five panel drug screens a year is over $300,000. In this study, it was found that 65% of the probation subjects were identified with the Eye Check™ Pupillometer as non drug impaired and confirmed with urine drug tests. Using the pupillometer solely, the Probation Department could have saved more

than half of the drug test expenditure. These funds could have been applied to more frequent testing and drug free compliance which is essential to reducing the rate of drug use.

Why is there a potential difference between the presence of measurable impairment, e.g., pupils, and the presence of a chemical substance , e.g., urinalysis. Drugs create impairment in various central nervous system functions. It may be exhibited in various ways in an impaired individual e.g., slurred speech, bloodshot eyes, difficulty balancing and walking. Many drugs, e.g., cocaine, opiates, alcohol, and marijuana, have short duration of their effects . It is during that period of the activity where the impairment is apparent. When the drug has worn off, the signs of the impairment are gone or have diminished significantly . However, the presence of a drug or drugs in urine does not provide information as to whether the individual is actually under the influence of the particular drug at that time unless impairment is measured concurrently Likewise, no determination can be made from urine as to the amount of or the time of the dose. For example, when smoked, the effects of cannabis begin almost immediately. The effects of smoked cannabis peak after about 20 minutes and last for 1-2 hours, however, the presence of cannabis metabolites may be present in the urine for 24 to 72 hours from a single use.

Consequently, the presence of the drug in the urine does not necessarily indicate impairment. It is fully possible to have a positive toxicological result without any sign of impairment. This was evident in several subjects in this study. As long as this discrepancy is recognized, the use of physiological based tests of impairment when compared with toxicological results will have appropriate meaning to the examiner.

Conclusions: The Eye Check™ pupillometer appears to effectively differentiate drug impaired subjects from normals in this study. The fifty-six percent identified as non drug impaired represents the number of subjects that could have been tested using the pupillometer alone yielding significant economic savings and probation staff time. Pupillometry has demonstrated its value as a tool in screening for drugs . Overall, it appears to be a valid and cost effective tool for its intended purpose . It requires minimal training to operate, is portable, and is adaptable to a variety of drug testing and screening programs. Further familiarization with the instrument, improved differential algorithms, and improved training in its use will most likely increase its sensitivity and specificity.

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