An Overview of Present and Future Drug Testing
David M. Martin, Ph.D.

Abstract
This article will provide a brief overview of existing drug testing technologies and approaches in a number of settings. It will offer a personal commentary from three decades of drug testing experience and participation in the development of the industry. It will also provide suggestions on the use of various specimens such as urine, hair and saliva alone and in combination. It will also address alternate testing specimens such as sweat, breath, surface and emerging technologies all with the goal of providing consumers of drug testing products a broader understanding of the current drug testing technologies available to them and a glimpse into the future.

Introduction
Over the past thirty years drug testing has evolved from a series of obscure laboratory tests to a multibillion dollar global industry that is constantly in the media and our lives. Athletes are in the press when they fail a drug test, but there are literally thousands of positive drug tests every day in a variety of industries. This is because drug abuse has been a part of our society for centuries; it is transcultural, international in scope and routinely found in a wide range of human endeavors causing injury, accidents and death. For decades the connection between drugs, weapons, crime and terrorism has been made abundantly clear and unfortunately has become a growth industry. The Drug Enforcement Agency (DEA) has identified at least seventeen foreign terrorist organizations with potential ties to the drug trade (narcoterrorism). A primary mission of the Department of Homeland Security (DHS) is to monitor and eliminate the connections between illegal drug trafficking and terrorism thereby cutting off their financing.

Drug funded terrorism and violence is not restricted to remote war zones but has crossed our country's southern border from the drug wars in Mexico to virtually every community in America. The fact that trafficking in illegal drugs finances not only criminal behavior but has been linked to international terrorism creates a new urgency to keep our society drug-free. Recreational drug abuse is not a victimless crime. It finances and promotes criminal behavior, gang violence and international terrorism worldwide. Drug testing is no longer simply a workplace safety issue or a tool to level the playing field in a sporting event; it is part of the effort to stop narcoterrorism and maintain our international security.

This article will provide a brief overview of existing drug testing technologies and approaches in a number of settings. It will offer a personal commentary from three decades of drug testing experience and participation in the development of the industry. It will also provide suggestions on the use of various specimens such as urine, hair and saliva alone and in combination. It will also address alternate testing specimens such as sweat, breath, surface and emerging technologies all with the goal of providing consumers of drug testing products a broader understanding of the current drug testing technologies available to them and a glimpse into the future.

Drug Testing Origins, the 1980s and Test Standardization
Drug testing falls into the area of forensic toxicology. This is one of the oldest practical applications of chemistry originally used by law enforcement for the detection of poisons in man, crime scenes and the environment. Tests for arsenic were performed by laboratories as far back as the late 1700s. In 1840, drug testing solved a murder investigation in the landmark Lafarge murder case in France by identifying arsenic in the victim. Laboratories continued to develop their own tests, standards and methods for determining poisons and other drugs. Unfortunately, there were no uniform standards, creating conflicting results from laboratory to laboratory. It wasn't until the 1980s that drug testing as we know it today became standardized. This was the result of a series of separate but related events in workplace, medical and sports drug testing.

In May of 1981, in unusually rough seas, a US Navy fighter jet was making a nighttime landing on the aircraft carrier USS Nimitz. The landing failed, and the crash resulted in the death of 14 crew members and injury to 40 others onboard the carrier. Forensic testing reported the presence of drugs in crew members. This created a series of investigations and recommendations that eventually led to President Ronald Reagan's issuance of Executive Order 12554 in 1986, establishing a drug free federal workplace. This laid the foundation for the establishment of drug testing programs for all federal employees. However, at that point drug testing technology was still not standardized and varied greatly from laboratory to laboratory.

At the same time, methadone maintenance programs in the United States were expanding and needed reliable drug tests to determine the medical compliance of methadone therapy and insure patients were abstinent. There were widespread complaints in the industry that laboratory results did not match clinical
An Overview of Present and Future Drug Testing
David M. Martin, Ph.D.

Abstract
This article will provide a brief overview of existing drug testing technologies and approaches in a number of settings. It will offer a personal commentary from three decades of drug testing experience and participation in the development of the industry. It will also provide suggestions on the use of various specimens such as urine, hair and saliva alone and in combination. It will also address alternate testing specimens such as sweat, breath, surface and emerging technologies all with the goal of providing consumers of drug testing products a broader understanding of the current drug testing technologies available to them and a glimpse into the future.

Introduction
Over the past thirty years drug testing has evolved from a series of obscure laboratory tests to a multibillion dollar global industry that is constantly in the media and our lives. Athletes are in the press when they fail a drug test, but there are literally thousands of positive drug tests every day in a variety of industries. This is because drug abuse has been a part of our society for centuries; it is transcultural, international in scope and routinely found in a wide range of human endeavors causing injury, accidents and death. For decades the connection between drugs, weapons, crime and terrorism has been made abundantly clear and unfortunately has become a growth industry. The Drug Enforcement Agency (DEA) has identified at least seventeen foreign terrorist organizations with potential ties to the drug trade (narco-terrorism). A primary mission of the Department of Homeland Security (DHS) is to monitor and eliminate the connections between illegal drug trafficking and terrorism thereby cutting off their financing.

Drug funded terrorism and violence is not restricted to remote war zones but has crossed our country’s southern border from the drug wars in Mexico to virtually every community in America. The fact that trafficking in illegal drugs finances not only criminal behavior but has been linked to international terrorism creates a new urgency to keep our society drug free. Recreational drug abuse is not a victimless crime. It finances and promotes criminal behavior, gang violence and international terrorism worldwide. Drug testing is no longer simply a workplace safety issue or a tool to level the playing field in a sporting event; it is part of the effort to stop narcoterrorism and maintain our international security.

This article will provide a brief overview of existing drug testing technologies and approaches in a number of settings. It will offer a personal commentary from three decades of drug testing experience and participation in the development of the industry. It will also provide suggestions on the use of various specimens such as urine, hair and saliva alone and in combination. It will also address alternate testing specimens such as sweat, breath, surface and emerging technologies all with the goal of providing consumers of drug testing products a broader understanding of the current drug testing technologies available to them and a glimpse into the future.

Drug Testing Origins, the 1980s and Test Standardization
Drug testing falls into the area of forensic toxicology. This is one of the oldest practical applications of chemistry originally used by law enforcement for the detection of poisons in man, crime scenes and the environment. Tests for arsenic were performed by laboratories as far back as the late 1700s. In 1840, drug testing solved a murder investigation in the landmark Lafarge murder case in France by identifying arsenic in the victim. Laboratories continued to develop their own tests, standards and methods for determining poisons and other drugs. Unfortunately, there were no uniform standards, creating conflicting results from laboratory to laboratory. It wasn’t until the 1980s that drug testing as we know it today became standardized. This was the result of a series of separate but related events in workplace, medical and sports drug testing.

In May of 1981, in unusually rough seas, a US Navy fighter jet was making a nighttime landing on the aircraft carrier USS Nimitz. The landing failed, and the crash resulted in the death of 14 crew members and injury to 40 others onboard the carrier. Forensic testing reported the presence of drugs in crew members. This created a series of investigations and recommendations that eventually led to President Ronald Reagan’s issuance of Executive Order 12554 in 1986, establishing a drug free federal workplace. This laid the foundation for the establishment of drug testing programs for all federal employees. However, at that point drug testing technology was still not standardized and varied greatly from laboratory to laboratory.

At the same time, methadone maintenance programs in the United States were expanding and needed reliable drug tests to determine the medical compliance of methadone therapy and insure patients were abstinent. There were widespread complaints in the industry that laboratory results did not match clinical
findings and could not be trusted. This initiated a blind study from the Centers for Disease Control (CDC) that highlighted the nature of this problem. The study resulted in a 1985 publication in the Journal of the American Medical Association entitled “Crisis in Drug Testing” which documented the problem of inconsistent results and widespread laboratory errors.

To address this issue, Executive Order 12564 charged the National Institute of Drug Abuse (NIDA) to develop standards that all laboratories would need to adopt in order to be accredited to conduct tests on federal employees. The “NIDA 5” drug testing panel was established. It tested urine specimens for marijuana, cocaine, amphetamines, opiates and phencyclidine (PCP) at specific screening and confirmation levels. This program is now under the Substance Abuse and Mental Health Service Administration, and the drug test panel is also referred to as the “SAMHSA 5”. This test became the standard of screening/confirmation guidelines, and for the first time a Medical Officer Review processes, chain of custody procedures and other standards were established by NIDA all to be implemented nationwide on January 1, 1990 by laboratories wanting to perform drug tests on federal employees. This was a landmark in the history and standardization of the drug testing industry. The largest federal program to use these standards was in the Department of Transportation and is still used as a benchmark for drug testing programs today.

The 1980s were significant for international sports drug testing as well. At the Olympic Games and international competitions, record breaking performances were made by the Soviet Union athletes. Suspicions about the use of hormones and other drugs had been circulating since the 1950s. At the 1988 Seoul Olympics one of the first comprehensive drug testing programs was put into place, resulting in the suspension of gold medal winner Ben Johnson after testing positive for steroids. This shocked the sporting world and opened up a new industry - sports drug testing or anti-doping programs. However, similar to drug testing in the United States prior to Executive Order 12564, the new anti-doping programs did not have consistent or clear standards from country to country or sport to sport. In 1989 an independent agency was ultimately set up to monitor all Olympic sports - the World Anti Doping Agency (WADA). Drug abuse was not restricted to Olympic events but also spread to professional sports and athletes. The fact that performance enhancing drugs worked, allowing athletes to win events and obtain lucrative endorsement contracts, created an entire illicit industry to promote and mask the abuse of performance enhancing drugs in athletes. Scandals in the Tour de France uncovered an elaborate network of medical doctors, trainers and pharmacies providing performance enhancing drugs and high tech programs to avoid detection which quickly spread internationally. In the United States federal investigations and prosecution of BALCO laboratory in San Francisco uncovered drug abuse scandals in Major League Baseball, athletics and other sports. These illicit programs create technical challenges for anti-doping programs and will persist as long as the sports industry and general public place such high monetary rewards on winning, regardless of how a victory is achieved or the long term consequences on the health of athletes.

“NIDA 5” and Expanded Urine Drug Testing

Executive Order 12564 mandated a drug free federal workplace in the United States and established the legal and technical basis for the drug testing of federal employees. In the 1990s federally mandated programs were the largest consumers of drug testing services in the country. An entire industry of accredited laboratories, third party administrators, medical review officers and specimen collectors was developed to address the new mandated guidelines. However, today the federal government is no longer the largest drug testing entity. Non-mandated programs eclipsed the federally mandated programs and continued to grow. Non-mandated programs are those that test employees not covered by the Executive Order for industries such as construction, sales, retail, professional services, treatment facilities, schools and the criminal justice systems. There are now more non-mandated employees that are drug tested than federally mandated employees, and a significant technical advance has occurred in this sector. Initially, all non-mandated testing mimicked the NIDA 5 panel as that was the most studied, litigated and used form of drug testing. However, non-mandated programs have a distinct advantage as they were not covered under Executive Order 12564 which limits the specimen tested to urine only for the NIDA 5 drugs. This allowed non-mandated employers to expand their profiles to drugs not included in the NIDA 5 but emerging as problems in the workplace such as synthetic opiates like Oxycontin. Non-mandated employers were also free to test alternative specimens such as hair and saliva. They were also free to use instant testing which could be done at an employer’s worksite, saving time and money.

Mandated programs established a firm legal and technical basis for testing the “NIDA 5” drugs in urine but have not progressed in the last 20 years to include alternative specimens such as hair, saliva or instant testing which are routinely used in a number of non-mandated industries. Nor have the mandated programs expanded to include additional drugs such as the synthetic opiates, barbiturates, benzodiazepines, antidepressants and other prescription drugs that are routinely abused today. In fact, mandates program guidelines prohibit the testing of additional drugs or alternative specimens at this time. Some mandated companies have addressed this limitation by collecting a second specimen under a separate company policy in order to test for drugs not currently in the NIDA 5 panel.

Arguments vary as to why expanded drugs and alternative specimens have not been included in mandated programs. It took years to codify the current mandated program and literally a decade to work out all the aspects of its implementation. Federally mandated programs have been very successful in reducing workplace drug abuse and will evolve with time. Employers who are mandated to have drug testing programs need to be aware that it is possible that some drug abuse may go undetected simply because only five drugs of abuse are screened under current mandated programs. The “NIDA 5” drugs are often abused in combination with other drugs that are not tested and as such may still be valid...
"signature" drugs to trigger an in-depth medical review by a substance abuse professional which may reveal a more extensive drug abuse pattern.

Today, the technology is routinely available in large laboratories to cost effectively test urine for expanded panels of 12 different classes of drugs. Some laboratories provide even more expanded panels of over 50 classes of drugs. These are panels that are routinely used by substance abuse treatment facilities that are rapidly making headway into non-mandated programs. Impaired Professional testing programs have led the way in the development of these expanded testing panels. These are workplace drug testing programs for recovering physicians, nurses and pharmacists who are tested several times a month to maintain their employment. Such health professionals have access to a wide variety of prescription drugs, and testing for the "NIDA 5" alone would be negligent.

If a zero tolerance program is required, it is these expanded panels that are entering Impaired Professional workplace testing as well as other non-mandated workplace programs. Innovative programs have been established by a number of State Physician Health Programs, laboratories and third party administrators that manage Impaired Professional testing programs. These programs cost effectively test for wide variety of drugs through adjusting profiles by expanding and contracting the drugs tested in panels over time. This way a donor never knows which drugs will be tested when called to provide a specimen. Also, these programs have the ability to test hair, saliva and other specimens if there is need to confirm a conflicting or challenged urine test result.

Adjusting profiles and specimens is a very effective emerging drug testing strategy: one week all the synthetic opiates as a class could be tested, and the next week all the stimulants as a class would be tested. A policy can be written that when a reasonable suspicion drug test is ordered and a specific class of drug is suspected (a cache of barbiturates is found in the workplace), an expanded barbiturate panel could be ordered. The cost would be less because not all classes of drugs are tested and more effective as the suspected drug class is tested in an expanded form.

**Blood, Urine, Hair, Saliva and Sweat Drug Testing**

Originally, only one specimen or specimen such as urine would be used in a drug testing program. Policies were built around that specific specimen. This was the model originally used by the federally mandated programs. Today, several types of specimens are available for drug testing, each having its own advantages and limitations (Table 1). Modern drug testing programs now can use multiple samples to more effectively identify drug abuse. The Olympic anti-doping programs now collect both urine and random blood specimens as human growth hormone and erythropoietin (EPO) can only be measured in a blood specimen. In a recent athletic doping case a hair specimen was collected and the negative result used to demonstrate that an extremely low urine concentration of cocaine could be the result of inadvertent exposure and not the result of chronic abuse.

Drugs of abuse are rapidly absorbed into the bloodstream once taken and then distributed to various tissues, excreted into saliva, urine and deposited into hair in that order. This makes each specimen unique in its concentration of drugs, detection times and ability to be used in drug testing programs. It is now possible to consider multiple specimens when evaluating an individual’s drug testing result, especially when the results of a single specimen are inconclusive or contested by the individual.

Urine testing is the gold standard for drug testing as drugs exist in concentrations several hundred to a thousand times more in urine than they do in saliva, blood or hair. Also, urine has been tested for decades with a wealth of technical and legal support in the world body of literature. However, urine is difficult to collect, direct observation is limited and expensive, and urine specimens can be easily diluted or adulterated to produce false negatives. There is an entire industry that provides a number of products to mask drug presence in urine by adding materials to the specimen, drinking various preparations and even using devices that produce drug free urine at body temperature through life like prostheses. For all these reasons, alternative specimens to urine for drug testing have long been sought and the top candidates are currently hair and saliva.

Hair testing offers the advantage of directly observing the specimen collection while having the ability to look back in time up to 90 days for drug abuse. Drugs enter hair follicles from the bloodstream and are permanently incorporated into the strands of hair. However, hair only grows about ½ inch per month, and it takes an average of 5-10 days after a drug is abused for that drug to enter a follicle and grow above the scalp line in sufficient length to be tested. In its current form, hair testing would not be able to detect recent abuse within the past few hours and as such is not applicable to post accident and has limited application to reasonable suspicion cases. Hair is routinely used in pre-employment and random drug tests and is extremely helpful in zero tolerance programs often detecting drug abuse that urine, blood or saliva would miss. There are also very little possibilities to cheat on a hair drug test even though a myriad of shampoos and other products claim to do so.

Saliva holds the most promise near term as it is the only sample that can be easily collected under direct observation, is not readily adulterated and can be tested instantly. Also, saliva drug concentrations parallel those found in blood so it can potentially be used to determine impairment and has been done so for alcohol intoxication. The use alcohol concentrations in blood have been well documented to indicate intoxication and these levels have been extended to breath and now saliva. Other drug concentrations in blood that cause impairment such as cocaine, marijuana, benzodiazepines and others are being established, and the possibility of extending these levels to saliva is encouraging. However, saliva specimens have very low concentrations of drugs similar to blood, making instant detection technically
challenging at this time. Laboratory based saliva testing has addressed this issue while providing confirmation of any instant screening results.

Sweat testing has a number of technical complications, and this factor has limited its growth in the industry. Sweat testing is accomplished by placing a patch on a donor’s skin for up to 14 days. The patch-based tests and are used in a phase laboratory based well. However, there was a move to cut manufacturing costs, and this not give a complete picture of an individual’s drug abuse pattern. Each sample has its on-market.

cheating. Direct routine screening tests. positives must positives and chain of custody documented in several court cases, sweat patches are curtail saliva tests hold the promise of solving the problem while providing discreet transmitted false panels expanded Inpatient or outpatient programs do not need to wait days for a negative drug test worked laboratory approach employs a sensor the size of a small cell phone on an ankle bracelet that detects transdermal (through the skin) alcohol in both sweat and vapor phase as it is excreted through the skin. The readings are transmitted to a receiver in the donor’s house that transmits the results to a central monitoring agency. The cost is about $10 per day and often paid for by the parolee as a condition of parole. This technology offers great promise as other drugs of abuse can be detected transdermally as demonstrated with the sweat patch. Even though more research is needed on testing drugs of abuse transdermally prior to routine application, this is clearly a path for the future of drug testing in specific applications.

**Instant vs. Laboratory Based Screening**

Instant urine drug tests using lateral flow technologies similar to those in pregnancy tests were developed in the early 1980s and worked well. However, there was a move to cut manufacturing costs, and this shifted manufacturing offshore where quality control and lack of standardization created a new crisis in drug testing. Instant tests were unreliable, and in addition to false positives, the greater concern was false negatives allowing drug abusers to return to work. In the 1990s these shortcomings were addressed, and now instant drug testing kits potentially outsell laboratory based tests and are used in a wide variety of industries. Instant tests are available in many forms, the most popular are the single test dip sticks, multiple test cassettes or multiple tests built into the collection cup. These tests now have technical performance characteristics similar to lab based tests for the NIDA 5 panel. It is important to keep in mind that these are screening tests, and as with laboratory based screening tests, positives must be confirmed preferably by gas chromatography/mass spectroscopy. Instant drug tests are the wave of the future as they will accurately screen out the negatives with lab based accuracy. Negative tests account for up to 90% of routine employment drug tests; rapidly screening these tests on site will save time and money.

These instant urine drug tests now sell in panels of ten or more tests including synthetic opiates. They also can test for adulteration or substitution through technology built into the collection cup. Instant drug testing products are widely available on the internet and have important applications in the substance abuse treatment market. Inpatient or outpatient programs do not need to wait days for a negative drug test result; negatives are instantly available and only positives need to be sent to a lab for confirmation. As with the impaired professional programs, these tests can be used with adjusting profiles to fit the individual tested or the behavior observed by the clinician. Simply having this capability is a deterrent to substance abuse. However, the difficulty of collecting a urine specimen limits the application of instant urine testing technologies to treatment facilities, doctor’s offices or mobile collection vans with bathrooms. As more sophisticated adulteration techniques enter the market, the integrity of a urine specimen can never be guaranteed 100 percent of the time, despite direct observation of the collection. Even under such close scrutiny, advanced lifelike internal and external prosthetic devices and procedures will enter that market that can deceive even the most careful direct observer.

Instant and laboratory based saliva tests hold the promise of solving the problem while providing discreet observation of the specimen collection to ensure its integrity. The low amount of drugs in saliva limits on-site instant testing to the NIDA 5 at this time, and the detection of marijuana remains a technical challenge. As such, instant saliva testing still needs further development to test for expanded panels similar to urine testing. Laboratory based saliva testing is now filling that technology gap to test for additional drugs while providing gas chromatography/mass spectroscopy confirmations of positives.

The market to cheat on drug tests is an internet phenomenon that has grown into an industry of products, pharmacies and professionals with ever ingenious methods of beating drug tests. Some of these products do indeed work, and direct observation of specimen collection is the first step to curtail cheating. Direct observation of urine collections presents logistical and gender specific problems that prevent its routine application and is usually reserved for the most problematic of cases. Even in sports anti-doping programs where direct observation is routine, some athletes claim they were able to circumvent the observation with prosthetic devices.

In summary, drug testing today has its strengths and limitations. An individual hair, urine, saliva or blood specimen alone will not give a complete picture of an individual's drug abuse pattern. Each sample has its own characteristics and detection time for specific drugs of abuse. The only way to insure the most complete drug test is done on an individual is to collect multiple specimens; a urine sample, a hair sample and a blood or saliva sample at the same time.
The Future of Drug Testing

Drug abuse has been part of the human experience for centuries; it destroys lives, families and literally costs billions of dollars in lost productivity, accidents and theft in the United States alone. Drug trafficking has become a global growth industry and fuels crime and terrorism internationally. The legislative initiatives to decriminalize drug possession along with the movement promoting the medicinal use of marijuana and other drugs create a de facto endorsement of drug abuse behavior. These related facts alone will make more drugs available in our society, and as such drug abuse will inevitably increase. As drug abuse increases, so will the need for drug testing. These tests will evolve to include wider panels.

Prescription medications and designer drugs that are being made in black market pharmacies. Drug testing has been demonstrated without a doubt that it deters drug abuse. The Quest Drug Testing Index has tracked employment testing for the last 19 years and has noted a steady decline in drug testing positives in workplace drug testing. For example, in 1988 13.6 percent of workers tested positive for drugs of abuse while in 2006 only 3.6 percent of the combined U.S. workforce tested positive for drugs. This is a phenomenal achievement, and our efforts to stop drug abuse in the workplace by drug testing have been successful and must continue. It is important to note that while there is a lowering of overall drug testing positives in these workplace populations, the studies primarily use the NIDA 5 drug testing panel and do not include tests for the abuse of prescription medications which are on the rise. Clearly, we have the mechanics set up to do the testing and reduce drug abuse; what is needed is to expand the scope of drugs tested and to insure specimen integrity.

As government regulations led the way for the establishment of drug testing in America in the 1980s, law enforcement’s current need for an early warning system to detect drugs entering the country have pointed to new drug testing strategies. Testing systems are now being used to detect drugs on surfaces to give law enforcement reasonable suspicion to search vehicles, cargo and luggage at airports and border crossings. There are various methods to test for drugs on surfaces using swabs to directly test items or areas and indirect methods using scanning technologies. Both have their advantages and disadvantages. These surface testing systems are not limited to use in the workplace and schools to insure the environment is drug free. If drugs are found in a specific area, this creates reasonable suspicion to increase surveillance in that area or to drug test individual’s urine, hair or saliva in that area. In addition, new technologies can readily detect drugs in the ambient room air and have been used to test for drugs in homes and industrial environments. Drug testing of the future will not be limited to the collection of biological specimens but will rely on environment testing of surfaces and ambient air to ensure that an area, whether a workplace, school or living space is truly drug free.

New sensing technologies will expand transdermal testing to include not only alcohol but drugs of abuse as well. Initially, these technologies will be used by law enforcement in parole programs for continuous monitoring of individuals under house arrest. This technology will rapidly be developed into handheld instruments designed to instantly determine drugs on transdermal specimens and potentially surfaces and air. Positive results would trigger more invasive testing of urine, hair, blood or saliva, depending upon the circumstance. Another specimen also receiving attention in diagnostic medicine is the breath specimen. Breath testing has been used for decades to detect alcohol abuse and other medical illnesses such as lung infections, lactose intolerance, bacterial overgrowth of the small bowel, celiac disease and, recently, lung cancers. It is not inconceivable that breath testing for drugs of abuse will also be developed as new and more sensitive detection technologies are developed and introduced into the industry. Transdermal, saliva and breath are the specimens that offer the most promise for roadside drug testing where the need is greatest. Drugged driving, driving cars under the influence of drugs, has now eclipsed drunk driving in a number of international studies and will only increase as the prescription and street drug abuse continues.

Screening for drugs on surfaces by law enforcement, is being done in Europe, Canada and Australia on a limited basis. Initially, these technologies will be used by law enforcement in parole programs for continuous monitoring of individuals under house arrest. This technology will rapidly be developed into handheld instruments designed to instantly determine drugs on transdermal specimens and potentially surfaces and air. Positive results would trigger more invasive testing of urine, hair, blood or saliva, depending upon the circumstance. Another specimen also receiving attention in diagnostic medicine is the breath specimen. Breath testing has been used for decades to detect alcohol abuse and other medical illnesses such as lung infections, lactose intolerance, bacterial overgrowth of the small bowel, celiac disease and, recently, lung cancers. It is not inconceivable that breath testing for drugs of abuse will also be developed as new and more sensitive detection technologies are developed and introduced into the industry. Transdermal, saliva and breath are the specimens that offer the most promise for roadside drug testing where the need is greatest. Drugged driving, driving cars under the influence of drugs, has now eclipsed drunk driving in a number of international studies and will only increase as the prescription and street drug abuse continues.

Screening for drugs on surfaces by law enforcement, is being done in Europe, Canada and Australia on a limited basis. Initially, these technologies will be used by law enforcement in parole programs for continuous monitoring of individuals under house arrest. This technology will rapidly be developed into handheld instruments designed to instantly determine drugs on transdermal specimens and potentially surfaces and air. Positive results would trigger more invasive testing of urine, hair, blood or saliva, depending upon the circumstance. Another specimen also receiving attention in diagnostic medicine is the breath specimen. Breath testing has been used for decades to detect alcohol abuse and other medical illnesses such as lung infections, lactose intolerance, bacterial overgrowth of the small bowel, celiac disease and, recently, lung cancers. It is not inconceivable that breath testing for drugs of abuse will also be developed as new and more sensitive detection technologies are developed and introduced into the industry. Transdermal, saliva and breath are the specimens that offer the most promise for roadside drug testing where the need is greatest. Drugged driving, driving cars under the influence of drugs, has now eclipsed drunk driving in a number of international studies and will only increase as the prescription and street drug abuse continues.

Screening for drugs on surfaces by law enforcement, is being done in Europe, Canada and Australia on a limited basis. Initially, these technologies will be used by law enforcement in parole programs for continuous monitoring of individuals under house arrest. This technology will rapidly be developed into handheld instruments designed to instantly determine drugs on transdermal specimens and potentially surfaces and air. Positive results would trigger more invasive testing of urine, hair, blood or saliva, depending upon the circumstance. Another specimen also receiving attention in diagnostic medicine is the breath specimen. Breath testing has been used for decades to detect alcohol abuse and other medical illnesses such as lung infections, lactose intolerance, bacterial overgrowth of the small bowel, celiac disease and, recently, lung cancers. It is not inconceivable that breath testing for drugs of abuse will also be developed as new and more sensitive detection technologies are developed and introduced into the industry. Transdermal, saliva and breath are the specimens that offer the most promise for roadside drug testing where the need is greatest. Drugged driving, driving cars under the influence of drugs, has now eclipsed drunk driving in a number of international studies and will only increase as the prescription and street drug abuse continues.

Screening for drugs on surfaces by law enforcement, is being done in Europe, Canada and Australia on a limited basis. Initially, these technologies will be used by law enforcement in parole programs for continuous monitoring of individuals under house arrest. This technology will rapidly be developed into handheld instruments designed to instantly determine drugs on transdermal specimens and potentially surfaces and air. Positive results would trigger more invasive testing of urine, hair, blood or saliva, depending upon the circumstance. Another specimen also receiving attention in diagnostic medicine is the breath specimen. Breath testing has been used for decades to detect alcohol abuse and other medical illnesses such as lung infections, lactose intolerance, bacterial overgrowth of the small bowel, celiac disease and, recently, lung cancers. It is not inconceivable that breath testing for drugs of abuse will also be developed as new and more sensitive detection technologies are developed and introduced into the industry. Transdermal, saliva and breath are the specimens that offer the most promise for roadside drug testing where the need is greatest. Drugged driving, driving cars under the influence of drugs, has now eclipsed drunk driving in a number of international studies and will only increase as the prescription and street drug abuse continues.
and several random testing systems. All this, along with the removal of license to work in their chosen profession, has led to a remarkable success rate. Drug testing has played an important part and will continue to play a front line role in the future of these and other programs. New drugs of abuse, designer drugs and methods of cheating are continually being developed and move from one industry to another, requiring drug testing scientists and professionals to constantly improve their drug detection technologies and ability to detect specimen adulteration.

A wide variety of technologies are now entering the drug testing industry driven by law enforcement's need to control drug trafficking, the point of care testing programs to reduce medical costs and the development of new detection technologies. All these will converge into a comprehensive drug testing program in the future where entire work areas will be tested. Air, surface and individuals will be tested using multiple specimens and expanded panels with the goal of insuring that we all can live and work in a safe, drug free environment.

Table 1. Comparison of blood, urine, hair, saliva, and sweat patch testing for NIDA 5 test (marijuana, cocaine, amphetamines, opiates and PCP)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Blood</th>
<th>Urine</th>
<th>Hair</th>
<th>Saliva</th>
<th>Sweat Patch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of Lab based screen</td>
<td>$150</td>
<td>$40</td>
<td>$90</td>
<td>$40</td>
<td>$40</td>
</tr>
<tr>
<td>Cost of Instant on-site screen</td>
<td>NA</td>
<td>$10</td>
<td>NA</td>
<td>$10</td>
<td>NA</td>
</tr>
<tr>
<td>Number of drugs tested</td>
<td>Large</td>
<td>Large</td>
<td>NIDA 5</td>
<td>NIDA 5 and alcohol</td>
<td>NIDA 5 and alcohol</td>
</tr>
<tr>
<td>Detection Window</td>
<td>4-24 hours</td>
<td>1-20 days</td>
<td>10-90 days</td>
<td>4-24 hours</td>
<td>1-20 days</td>
</tr>
<tr>
<td>Collection Invasiveness</td>
<td>Significant</td>
<td>Moderate</td>
<td>Minimal</td>
<td>Minimal</td>
<td>Minimal</td>
</tr>
<tr>
<td>Determine impairment</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Possibly</td>
<td>Possibly</td>
</tr>
<tr>
<td>Possibility of cheating</td>
<td>Low</td>
<td>High</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Best application</td>
<td>Post accident, reasonable suspicion</td>
<td>All types of testing</td>
<td>Pre-employment, clinical</td>
<td>Post accident for alcohol, clinical</td>
<td>Criminal Justice, clinical</td>
</tr>
</tbody>
</table>

Note: These are general guidelines; individual drugs will vary in time detected

**Author Information**

David M. Martin, Ph.D

Over the past 30 years David Martin has not only been actively involved in psychiatric and substance abuse research but also has co-founded several commercial drug testing and specialty laboratories. He was a member of the International Olympic Committee (IOC) Medical Commission special working group to harmonize sports anti-doping programs, Anti-Doping Administrator for the International Tennis Federation and National Hot Rod Association, and built one of the first NIDA now SAMHSA federally accredited drug testing labs in America. He is currently a courtesy Assistant Professor in the Department of Psychiatry at the University of Florida, the Chairman-Elect of the Drug and Alcohol Testing Industry Association (DATIA), the President and Chief Executive Officer of JMJ Technologies and the Scientific Team Leader of a U.S. State Department, Bureau of International Narcotics and Law Enforcement program studying Opium abuse in Afghanistan in women and children.

**Conflict of Interest Statement**

The author declares that he has no competing interests or conflicts of interest, and that this article was not paid for, inspired, reviewed or edited by a commercial sponsor.

**Suggested Reading**

United States Policy Towards Narco-Terrorism in Afghanistan, Testimony by Karen Tandy, Drug Enforcement Agency Administrator to the Committee on International Relations of the U.S. House of


Hansen HJ, Caudill SP, Boone DJ PhD Crisis in Drug Testing: Results of a Centers for Disease Control (CDC) blind study. Journal of the American Medical Association, 1985; 253:282


© Copyright 2006 - 2010 The Journal of Global Drug Policy and Practice