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Research On Drug Evidence

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Presented by: Joseph P. Bono

Prepared by: Robert F.X. Klein and Patrick A. Hays

**U.S. Department of Justice
Drug Enforcement Administration
Office of Forensic Sciences
Special Testing and Research Laboratory
3650 Concorde Parkway, Suite 200
Chantilly, Virginia 20151
USA**

ROUTINE AND IMPROVED ANALYSIS OF DRUG SUBSTANCES

Issue:

Improved methods of analysis, i.e., faster, more discriminatory, more sensitive, less costly, etc., are needed for all drugs of abuse. Additionally, standard analytical data are required for previously unknown drugs of abuse and/or new homologue or analog (i.e., "designer"-type) drugs.

Solution:

Illicit drug seizures and clandestine laboratory operations are continuously monitored to provide a comprehensive overview of new developments. Ongoing research in the forensic community, as well as in the general field of analytical chemistry, provide new and/or improved methods of analysis for both routine and specialized analyses of seized drugs. Reports providing standard analytical data for new drugs and/or improved analytical protocols for known drugs are generated for the forensic and enforcement communities.

Recent Developments:

In the United States, use of methamphetamine continues to increase. Use of amphetamine and other homologue/analog phenethylamines (often sold as methamphetamine) also continue to increase. Use of heroin, cocaine, anabolic steroids, human growth hormones, and LSD have stabilized or decreased. However, use of designer drugs - notably the various methylenedioxyamphetamines (MDA□s) - are rapidly increasing. Use of gamma-hydroxybutyric acid (GHB), *gamma*-butyrolactone (GBL) and 1,4-butanediol (BD) are also increasing. Abuse of flunitrazepam (Rohypnol) and other benzodiazepines as so-called □date-rape□ drugs has decreased concurrent with the increases in the use of the MDA□s, GHB, GBL, and BD. The marketing of commercial products derived from hemp (cannabis) continues to expand. Similarly, the marketing of various □controlled substance mimics□ (usually via Internet sales) continues to increase; the majority of these mimics are complex mixtures of non-controlled plants and/or over-the-counter type drugs, which are alleged to imitate the physiological effects of marijuana.

In Europe and Russia, use of amphetamines, methylenedioxyamphetamines, and heroin remains widespread, while use of cocaine continue to grow. In the Far East, Australia and New Zealand report general across-the-board increases in drug abuse (especially cocaine and methamphetamine), while methamphetamine use remains ubiquitous in Japan and is rapidly increasing in Cambodia, Thailand, Vietnam, and elsewhere along the Pacific Rim countries, with the spread of so-called □Thai Tabs□ (actually primarily produced in Burma/Myanmar) driving the increase. Heroin use in the People□s Republic of China is expanding rapidly, especially in the provinces adjoining the Golden Triangle region. Cocaine use is also increasing throughout South America (especially Brazil) and the Far East. Use of cocaine, heroin, Mandrax (methaqualone), amphetamine, LSD and methylenedioxyamphetamines all continue to increase in South Africa.

Summary:

Since 1998, several minor reviews of forensic analysis of drugs of abuse have appeared, and an International Scientific Working Group (SWGDRUG) has begun to formalize standards for forensic laboratories. Routine and/or new/improved methods of analysis have been reported for amphetamines, various substituted amphetamines, barbiturates, benzodiazepines, 4-bromo-2,5-dimethoxyphenethylamine (NEXUS) and related poly-substituted phenethylamines, cocaine, dihydroetorphine and etorphine, etonitazene, fentanyl, flunitrazepam (Rohypnol), heroin, *gamma*-hydroxybutyric acid (GHB), *gamma*-butyrolactone (GBL) and 1,4-butanediol (BD), inhalants, ketamine, LSD, marijuana and related cannabinoids, methamphetamines, methaqualone, methcathinone, methylenedioxyamphetamines and related compounds, morphine, codeine, and related opium alkaloids, opiate alkaloids, opium, 2-phenylethylamine (*beta*-phenethylamine) and related compounds, phenylpropylmethylamine, psilocybin, psilocin, and bufotenine, salvia divinorum, sibutramine, steroids, telazol, and terbinafine.

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NOVEL SYNTHESSES OF ILLICIT DRUGS, PRECURSORS AND ESSENTIAL CHEMICALS

Issue:

Forensic chemists must maintain familiarity with existing and new clandestine syntheses of illicit drugs in order to assist enforcement activities, to ensure safety and effectiveness during enforcement operations, and to provide expert testimony in legal proceedings.

Solution:

Illicit drug seizures and clandestine laboratory operations are continuously monitored to maintain a comprehensive overview of the field. In cases where new drugs are synthesized, or new methodologies are utilized, case reports are generated for the forensic and enforcement communities.

Recent Developments:

Continuing use of the Internet has spread a wide variety of both new and old synthetic procedures for all drugs throughout the world. In the United States, the most prevalent synthetic drug is methamphetamine, produced on both large and small (□cottage industry□) scales. Large-scale operations are centered in Mexico and California (Mexican run), and are based on ephedrine reduction with hydriodic acid. Similarly, most small-scale operations have concentrated on reduction of ephedrine or pseudoephedrine to methamphetamine, using a variety of synthetic routes. Use of commercial pseudoephedrine and phenylpropanolamine tablets as precursor sources continue to increase. Use of active metal reductions (i.e., with lithium or sodium metals in ammonia), and iodine-based reductions with hypophosphorous acid, both continue to increase. Use of unusual solvents for salting out procedures, including new refrigerants (Freons), camping stove fuels, and industrial solvents, has dramatically increased. Reductive aminations of phenylacetone continue, but only at a low level.

New designer drugs have also appeared, but are mostly isolated incidents arising from single operations. The only significant exception are the methylenedioxyamphetamines (MDA□s), which are now a worldwide abuse problem. Virtually all MDA□s are produced via reductive aminations of the corresponding ketone; large (industrial-scale) operations are primarily based in Europe, but similar large scale production laboratories have been identified in South Africa and in Asia. One new analog drug which may become a significant problem is 2,5-dimethoxy-4-*n*-propylthiophenethylamine (2C-T-7), which is one of the hundreds of analog drugs developed by Alexander Shulgin (author of PIHKAL and TIHKAL). In Europe, amphetamines are also commonly produced on industrial scales. In Southeast Asia, illicit production of methamphetamine has exploded, with manufacture of so-called □Thai Tabs□ (methamphetamine tablets, commonly also containing caffeine) becoming a major industry in Burma/Myanmar and the People□s Republic of China.

The abuse of *gamma*-hydroxybutyric acid (GHB) and its corresponding cyclic lactone *gamma*-butyrolactone (GBL) have also dramatically increased over the past 5 years, primarily in Europe and the United States. Originally utilized as a steroid substitute and "health food supplement" in bodybuilding circles, GHB became popular as a fast-acting hypnotic/sedative, and rapidly spread via the "rave" party scene. It is clandestinely produced from *gamma*-butyrolactone (GBL), and clandestine chemists soon realized that GBL is in chemical equilibrium with GHB, and could therefore be utilized interchangeably with GHB. This is a significant complication in enforcement efforts against GHB, since GBL is a fairly widely used industrial chemical. In an additional complication, it has been discovered that 1,4-butanediol (BD) and (to a lesser extent) tetrahydrofuran (THF) both convert to GHB in the body, and both of these industrial chemicals are now also being abused as GHB. Several methyl and dimethyl analogs of GHB and GBL have also been reportedly abused.

In southwestern Asia, especially Afghanistan, opium, morphine and heroin production has exploded. In South America, coca cultivation in Bolivia and Peru has dramatically decreased, but cultivation in Colombia has hugely increased. Brazil, Ecuador, and Venezuela are becoming increasingly involved in cocaine production and trafficking. A large variety of commercially available farming and industrial products have been used as effective substitutes for "classic" reagents in cocaine production, especially in Colombia. Industrial production of essential chemicals in Bolivia, Peru and especially Colombia has increased as importation of these same materials has become increasingly restricted. Production of heroin continues to increase in Colombia, and Ecuador and especially Peru are increasingly involved in opium cultivation in support of Colombian heroin production.

Summary:

Since 1998, a variety of alternate precursors, unusual substitutes for essential chemicals, and new or modified synthetic methods have been reported.

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CLANDESTINE LABORATORY APPRAISALS AND SAFETY

Issue:

Forensic chemists must maintain familiarity with clandestine laboratory procedures, setups, and techniques in order to assist enforcement activities, to ensure safety and effectiveness during enforcement operations, and in order to provide expert testimony in Court proceedings.

Solution:

Clandestine laboratory operations are continuously reviewed to provide a comprehensive overview of the field. In cases where new methodologies are noted, or unusual safety concerns are salient, reports are generated for the forensic and enforcement communities.

Recent Developments:

Expanding use of the Internet has spread a wide variety of clandestine laboratory methodologies throughout the world, including basic set-up procedures, adaptations of standard consumer products as substitutes for laboratory glassware, equipment, and essential chemicals, concealment techniques, covert surveillance and counter-surveillance techniques, and booby trapping. Numerous websites and □chat-lines□ are dedicated to illicit drug production and/or use.

Summary:

Since 1998, a number of clandestine laboratory reports have been published.

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REFERENCE DRUG STANDARDS AND TOTAL SYNTHESSES

Issue:

Many reference drug standards or structurally related internal standards are either commercially unavailable, or if available are extremely expensive.

Solution:

Controlled substances and their structural or isotopically labeled analogs are synthesized as needed. Internal standards are also prepared as needed. Case reports are published for new or unusual standards or improved synthetic approaches.

Recent Developments:

Increasing use of single ion-monitoring techniques for identification and quantitation of controlled substances and/or precursor compounds and essential chemicals has necessitated the development and use of isotopically labeled analogs, enantiomers, or closely related structural isomers.

Summary:

Since 1998, several reports detailing □ total syntheses □ of various controlled substances have been reported.

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COMPARATIVE ANALYSES

Issue:

Comparative analysis (i.e., the systematic application of impurity profiling for determination of commonality of origin) is complicated due to both the high complexity of the data and the large numbers of exhibits. Improved analytical and data handling techniques are needed.

Solution:

In-depth analysis via improved instrumental methodologies help identify discriminatory components in impurity profiles. Computer databases, sorting programs, and pattern recognition/neural networks provide enhanced data handling and analysis. Case reports of new methodologies are generated for the forensic and enforcement communities.

Recent Developments:

In conjunction with impurity profiling, a number of comparative analysis protocols were reported.

Summary:

Since 1998, comparative analyses have been conducted on heroin, and tablet and capsule logos.

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SOURCE DETERMINATION OF DRUGS (IMPURITY PROFILING)

Issue:

Impurity profiling of drugs is important for comparative analysis protocols, geosourcing, and synthetic route determinations. However, although certain drugs have been well characterized with respect to their impurity profiles, most have not been properly investigated.

Solution:

High sensitivity analytical techniques (primarily chromatographic) provide detailed profiles of trace-level impurities, ions, trace metals, and stable isotopes. Identification of individual impurities enhance origin identification and comparative analyses and also aid in development of internal standards for improved accuracy and precision of analysis. Case reports are generated for the forensic and enforcement communities.

Recent Developments:

Since 1998, the ongoing and systematic effort to identify impurities and establish signature profiles via in-house syntheses has continued and expanded. Heroin impurity profiling continues in the United States, Australia, and Germany. Cocaine impurity profiling continues in the United States and Europe, and has expanded in South America. Amphetamine profiling continues in Northern Europe, and methamphetamine profiling is expanding in the United States, Japan, and Australia. Analysis of occluded solvents in finished products (notably cocaine, heroin, and methamphetamine) continues, and stable isotope analyses (notably Isotopic Ratio Mass Spectrometry and Inductively Coupled Plasma/Mass Spectrometry) have expanded.

Summary:

Since 1998, impurity profiling has been conducted on amphetamine, cocaine, heroin, marijuana, methamphetamine, 4-methoxyamphetamine, methylenedioxy-amphetamines, opium, and occluded solvents.

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ANALYSIS OF ADULTERANTS AND DILUENTS

Issue:

Most "street-level" drugs are "cut" with various adulterants and diluents. Separation and identification of these extraneous materials can be tedious, especially in exhibits that contain many components. In addition, new or unusual adulterants and/or diluents are occasionally identified in drug exhibits, and standard analytical data are required for these substances. Finally, improved methods of analysis, i.e., faster, more discriminatory, less costly, etc., are needed for all cutting agents.

Solution:

Illicit drug seizures are continuously monitored to provide a comprehensive overview of adulterants and diluents. Case reports providing standard analytical data for new and/or unusual cutting agents are generated for the forensic and enforcement communities. Ongoing research in forensic community provides new and/or improved methods of analysis for routine identification of all adulterants and diluents.

Recent Developments:

In the United States, the extensive use of over-the-counter ephedrine or pseudoephedrine containing products for methamphetamine production has resulted in numerous reports on these two precursors. It is increasingly common to identify cocaine in South American heroin, and South American heroin in cocaine. □Thai Tabs□ are usually cut with caffeine, and some may contain ketamine as well. □Ecstasy□ tablets may contain a mixture of methylenedioxyamphetamines and/or homologue/analog drugs. Use of infrared, Raman, or nuclear magnetic resonance spectroscopy for the simultaneous identification of moderate quantities (i.e., 5 - 20 %) of certain cutting agents in cocaine or heroin is increasing.

Summary:

Since 1998, several reports detailing common cutting agents were published.

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NEW AND/OR IMPROVED INSTRUMENTAL TECHNIQUES

Issue:

Forensic Chemists must maintain familiarity with updates in current instrumental techniques and become versant in new, improved methods of analysis.

Solution:

Improved/existing and new technologies are reviewed and applied to both routine and specialized analyses of drugs. In cases where improved performance is observed, case reports are generated for the forensic community.

Recent Developments:

Capillary electrophoresis and related techniques have moved to the forefront of liquid chromatographic analyses of controlled substances. Advanced applications have included direct chiral discrimination of optical isomers without derivatization or specialized columns. Specialized injection techniques have enhanced detection limits for a variety of liquid chromatographic and gas chromatographic techniques. Raman spectroscopy has been investigated for identification of controlled substances (and shows great promise for portable instrumentation). Laser-induced fluorescence has been utilized for ultra-trace level detection of both controlled substances and their associated impurities.

Summary:

Since 1998, a variety of new and/or improved/existing instrumental methods have been utilized for drug analysis; most have been based on capillary electrophoretic and Fourier transform infrared and/or Raman techniques.

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PORTABLE DETECTION AND ANALYTICAL INSTRUMENTATION

Issue:

New trade agreements and the easing of formally restrictive national and international borders have resulted in dramatic increases in cargo transshipments and personal travel, thereby complicating drug inspection and interdiction efforts at POE's. Discovery and confirmational analysis of suspected drugs in cargo or on individuals is severely hampered by the lack of on-site detection and/or analytical equipment.

Solution:

Development of portable and highly sensitive detectors for drug detection and analyses allows law enforcement personnel and/or forensic chemists to perform screening type analyses on-site. In those cases where new methodologies have proven effective, case reports are generated for the forensic and enforcement communities.

Recent Developments:

Use of ion mobility spectrometers has become routine in the United States, and has resulted in numerous seizures of controlled substances (primarily cocaine) at POE's, highway monitoring stations, on board marine vessels (both in port and on the high seas), and at individual buildings (both residential and commercial). Other ongoing efforts involve further miniaturization of various GC, GC/MS, and ion mobility-type instruments, and development of new technologies based on surface-acoustic-wave (SAW), pulsed neutron or biosensor technologies. This field continues to expand very rapidly; however, most reports are proprietary and are rarely reported in forensic chemistry journals.

Summary:

Since 1998, a variety of new, portable vapor and/or particle detectors have been reported for drug analyses. Several instruments based on fast neutron analyses have also been reported.

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