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Toxicology News

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Acetyl Fentanyl

"New Heroin" Leads to Opiate Fatalities

By Michael A. Wagner, PhD, Jeffery H. Moran, PhD, Amy L. Patton, MS, and Laurie Ogilvie, MS

The past few years have seen an explosion of new, clandestinely produced synthetic drugs. These drugs have generally fallen into two general categories—synthetic, hallucinogenic stimulants (commonly known as bath salts) and synthetic cannabinoids (known as K2 or Spice). Recently, a new drug from the opioid family made a macabre entrance onto the stage.

In 2013, acetyl fentanyl was responsible for a number of fatalities and overdoses. The Rhode Island Real-time Outbreak and Disease Surveillance system reported a spike in overdose deaths from March through May. Fourteen individuals ranging in age from 19 to 57 years died from acetyl fentanyl overdoses, with the potential that more cases went undetected from incomplete emergency department reporting. These overdoses were clustered in close proximity to one another, indicating a possible common source (1).

In the first few months of 2013, the state of Pennsylvania recorded 50 deaths of addicts using fentanyl and its analogue, acetyl fentanyl. The problem quickly surfaced in 13 more states. The Centers for Disease Control and Prevention (CDC) issued an emergency warning about the appearance of this new analogue that included a treatment recommendation that large doses of naloxone may be needed as an antidote because of the high potency of acetyl fentanyl (2).

Fentanyl History

Fentanyl is a powerful synthetic opiate analgesic with a rapid onset and short duration of action. First synthesized in the 1960s and used as a general anesthetic, more recent applications include use to relieve severe acute and chronic pain. Fentanyl's analgesic potency is some hundred times greater than morphine's, and thus it is effective in low doses. This potency can lead to accidental deaths and overdoses when used recreationally or unknowingly as an adulterant in other street drugs.

The 2013 opiate deaths reflect a growing nationwide trend over the past 15 years. Opiate-related poisoning deaths have increased more than 650%, including from both prescription drugs and drugs of abuse (3,4). The cycling between prescription drugs and drugs of abuse has been driven by cost and availability. In the early 2000s, as prescription drugs became more available, their abuse increased. When the increase in abuse of prescription drugs led to investigations of questionable prescribing practices, street drugs such as heroin became relatively more affordable. With this increase in street drug use came the added risk of dubious drug quality and lethal adulterants (5).

Fentanyl Analogues

The recent morbidity and mortality reports involving acetyl fentanyl are not the first involving fentanyl or its analogues. In 2006, a fentanyl overdose epidemic killed 260 individuals in Philadelphia alone.

In 1979, the first fentanyl analogue, known as China white, appeared on the streets of California. Since then 15 analogues have been synthesized; seven of them are shown in Figure 1 (4). Through the years, these analogues have had various street names, including Apache, China girl, China white, dance fever, friend, goodfella, jackpot, murder 8, TNT, 24K, theraflu, bud ice, and recently Tango and Cash (6,7,8,9).

Variations in the parent fentanyl structure can

Continued on page 2

Inside...

Chronic Pain Management 7
Continuing Education Opportunities 9
ACCENT Credit 10

Acetyl Fentanyl

Continued from page 1

lead to analogues with profound pharmacological differences. Parent fentanyl is 80 to 100 times more potent than morphine, and some of its analogues are up to 10,000 times more potent. Acetyl fentanyl, however, is less potent than fentanyl. Many fentanyl analogues are lipophilic, have onset of action within minutes, and have short half-lives (10,11).

These drugs can be highly toxic. Acetyl fentanyl has obvious similarities to its schedule II parent, but it is not common on the illicit scene. No human data exists on its potency and lethality. In mice, the potency was 15.7 times higher than morphine but threefold lower than fentanyl. In acute toxicity studies, acetyl fentanyl is 6.7 times more lethal (LD_{50}) than fentanyl, with heavy intestinal bleeding a noteworthy symptom. In addition to analgesia, other pharmacological effects of fentanyl-like substances include euphoria, cough suppression, miosis, and respiratory depression (12).

In the previously mentioned deaths in Rhode Island, circumstances surrounding the deaths of suspected addicts implicated opiates, but initial toxicology testing failed to confirm their presence. Immunoassay screening of blood samples tested strongly for fentanyl, but gas chromatography-mass spectrometry (GC-MS) confirmation failed to find either fentanyl or norfentanyl. A distinct chromatographic peak in all the samples was consistent with acetyl fentanyl. The identity of this unknown substance was confirmed through a qualitative reference standard received from the Drug Enforcement Administration (DEA). In addition, physical evidence from the scenes confirmed positive for acetyl fentanyl. Acetyl fentanyl differs from fentanyl by a methylene group (Figure 1). See Table 1 and Figure 2 for the analytical reference data and mass spectrum reported by the Rhode Island laboratory (13).

The Scientific Working Group for the Analysis of Seized Drugs (SWGDRUG) provides reference mass spectra that differ in ion ratios for the acetyl fentanyl-HCl powdered standard from the DEA. Table 2 and Figure 3 show the ion ratios under the instrument conditions (14). Note that the ion ratios change in different pH preparations.

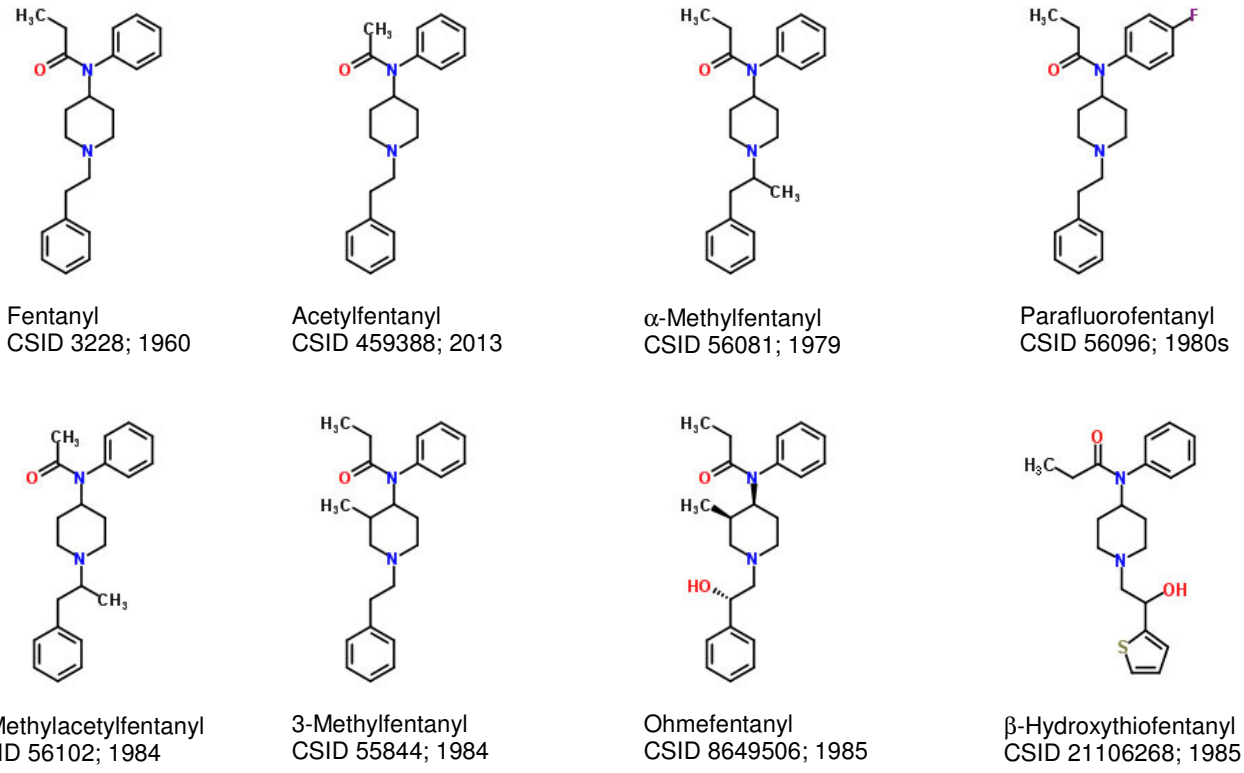

Figure 1 Fentanyl and some Analogues (6)
CSID = ChemSpider ID; Year = Year introduced

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Table 1. Rhode Island State Health Laboratories Data on Acetyl Fentanyl (13)

General information	
Chemical name:	N-Phenyl-N-[1-(2-phenylethyl)-4-piperidinyl] acetamide N-(1-Phenethyl)-4-piperidyl) acetanilide
Synonyms:	Acetanilide
Chemical formula:	$C_{21}H_{26}N_2O$
Molecular weight:	322.205 g/mol
CAS number:	003258-84-2
Toxicology	
Extraction:	Recovered by routine n-butyl chloride liquid:liquid basic drug extraction, including an acid back extraction. Sensitivity of method not yet established.
Detection:	GC/MS electron ionization scan Ions 231, 146, 188 m/z and earlier eluter metabolite/breakdown ANPP 146, 189 m/z
Elution order:	Citalopram, ANPP, paroxetine, acetyl fentanyl, fentanyl, zolpidem

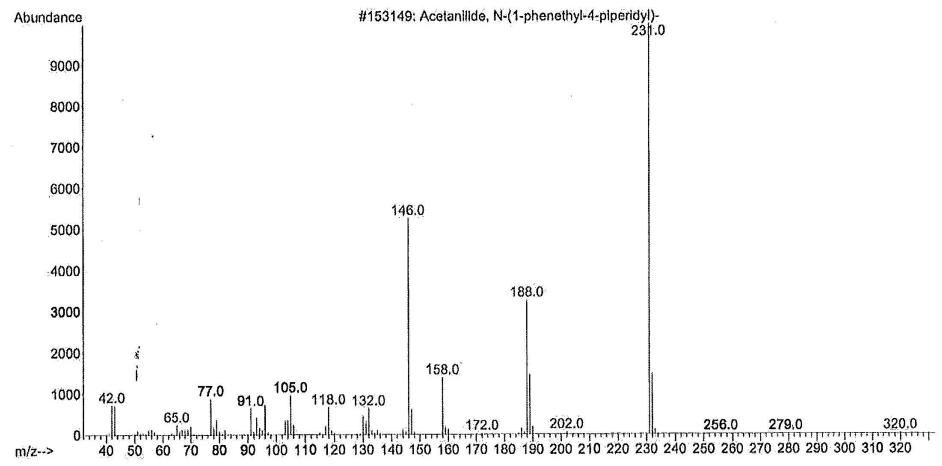

Figure 2. Acetyl Fentanyl Basic Extraction Mass Spectrum (13)

New Analytical Method

Patton et al. developed a method that couples solid-phase extraction (SPE) with liquid chromatography tandem mass spectrometry (LC-MS/MS) to identify acetyl fentanyl and acetyl norfentanyl in urine (15). The researchers collaborated with Cayman Chemical (Ann Arbor, Mich.) to develop certified calibration and quality control standards for acetyl fentanyl, acetyl norfentanyl, and their deuterated analogues. Prior to the LC-MS/MS analysis, they matrix-matched appropriate standards and quality control samples in human urine. They also hydrolyzed urine samples with ß-glucuronidase to ensure that the method would work in hydrolyzed solutions.

Following these preparations, the researchers used SPE on a polymeric strong-cationic exchange column to clean up the samples prior to LC-MS analysis. Following washes with 0.1% formic acid and a 70:30 water/methanol solution, drugs were removed with a basic 50:50 methanol/acetonitrile solution. Eluents were dried and then reconstituted in a mobile-phase mixture.

The method used two analytical columns. The first was a phenyl-hexyl (2.6 µm, 100 Å) analytical column (50 mm x 4.6 mm) heated to 30 ºC. The optimal flow rate for this system was set for 600 µl/min. The slow flow rate assisted in separating isobaric interferences. The second analytical column, which provided a secondary confirmation technique, was a biphenyl (2.7 µm) column (50 mm x 3.0 mm) and used the same mobile phase at a higher flow rate (800 µl/min).

Electrospray Detection

The electrospray mass spectrometer was set for positive ionization mode. Source (GS1/GS2), curtain, and collision gases used nitrogen with settings of 50 cm/s, 50 cm/s, and 20 cm/s, respectively. Table 3 shows the parameters for the specific reaction monitoring acquisitions. Individual enhanced product ion (EPI) settings were: 4000 Da/S; 800–600 Da; declustering potential (DP) 60 V; collision energy spread (CES) 5 V; and collision energy (CE) 35 V. Under these conditions, spiked human urine controls at the high (75 ng/mL) and low (3.75 ng/mL) concentrations produced six sets of results for both acetyl fentanyl and acetyl norfentanyl. For the high-concentration control, inter-day and intra-day coefficients of variation were below 10% and 8%, respectively. For the low-concentration control, the inter-day and intra-day values were below 10% and 15%, respectively. The lower limit of quantification was 1.06 ng/mL for acetyl fentanyl and 1.62 ng/mL for acetyl norfentanyl, and the limit of detection was less than 0.5 ng/mL for acetyl fentanyl and 1 ng/mL for acetyl norfentanyl.

The researchers also performed in vitro experiments using pooled human liver microsomes that demonstrated that acetyl fentanyl is metabolized by cytochrome P450s to acetyl norfentanyl. Urine samples from rats treated with a toxic dose of acetyl fentanyl contained high concentrations of acetyl fentanyl and acetyl norfentanyl.

This study describes a sensitive and specific LC-MS/MS method that detects quantitatively acetyl fentanyl and the predicted human metabolite, acetyl norfentanyl, in urine. In conjunction with existing

Table 2. Gas Chromatography-Mass Spectrometry Data on Acetyl Fentanyl (14)

Sample preparation:	Dilute ~1 mg/mL in chloroform
Instrument:	Agilent gas chromatograph operated in split mode with MS detector
Column:	DB-1 MS (or equivalent): 30 m x 0.25 mm x 0.25 µm
Carrier gas:	Helium at 1 mL/min
Temperatures:	Injector: 280º C
	MSD transfer line: 280º C
	MS source: 230º C
	MS quad: 150º C
	Oven program:
	1) 100º C initial temperature for 1.0 min
	2) Ramp to 300º C
	3) Hold final temperature for 9.0 min
Injection parameters:	Split ratio = 20:1, 1µl injected
MS parameters:	Mass scan range 30–550 amu
	Threshold: 100
	Tune file: stune.u
	Acquisition mode: scan
Retention time:	16.843 min

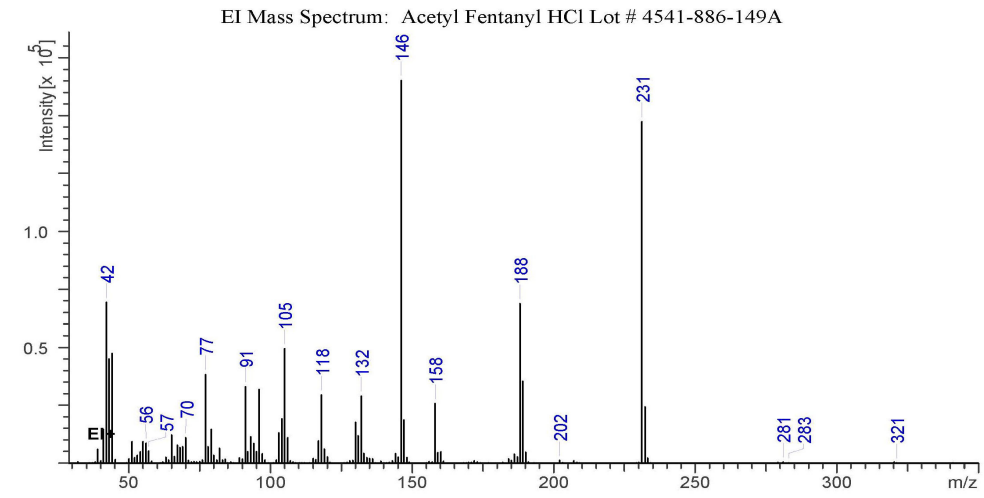

Figure 3. Acetyl Fentanyl HCl Mass Spectrum (14)

GC-MS techniques, the new method gives toxicology laboratories the capability to detect the drugs responsible for these kinds of opiate-related deaths.

Death Scene Investigation Guidelines

As the cases in Rhode Island illustrate, the certification of opiate deaths can be complicated and requires a close relationship between the medical examiner's or coroner's office and the toxicology laboratory. Although the death scenes implicated opiates, the initial toxicology results did not identify the drugs. Persistent toxicological testing uncovered this new analogue and resulted in case interpretation and a CDC warning.

An expert panel from the National Association of Medical Examiners and the American College of Medical Toxicology published a guideline for these investigations (16). The guideline recommends:

"1. A complete autopsy is necessary for optimal interpretation of toxicology results, which must also be considered in the context of the circumstances surrounding death, medical history, and scene findings.
"2. A complete scene investigation extends to reconciliation of prescription information and pill counts.
"3. Blood, urine, and vitreous humor, when available, should be retained in all cases. Blood from the femoral vein is preferable to blood from other sites.
"4. A toxicological panel should be comprehensive and include opioid and benzodiazepine analytes, as well as other potent depressant, stimulant, and antidepressant medications.
"5. Interpretation of postmortem opioid concentrations requires correlation with medical history, scene investigation, and autopsy findings.
"6. If death is attributed to any drug or combination of drugs (whether as cause or contributing factor), the certifier should list all the responsible substances by generic name in the autopsy report and on the death certificate.
"7. The best classification for manner of death in death due to the misuse or abuse of opioids without any apparent intent of self-harm is 'accident.' Reserve 'undetermined' as the manner for the rare cases in which evidence exists to support more than one possible determination."

The panel also recommends that additional toxicological testing be performed in cases involving a known history of prescription or illicit opioid use; scene evidence of drug abuse; autopsy findings suggesting drug abuse, including needle marks, liver damage, or other histological findings; gross pathological findings such as fluid-filled lungs or foamy airways; smuggling or suspicion of body packing; no obvious identified autopsy result; drug interactive contributions to a natural cause; and trauma.

SAMHSA Recommendations

A panel of experts convened by the Substance Abuse and Mental Health Services Administration also produced guidelines for evaluations of opioid-related deaths (17).

Table 3. Specific Reaction Monitoring Parameters for Acetyl Fentanyl Method (15)

Analyte	Q1 (*m/z*)	Q3 (*m/z*)	DP (V)	EP (V)	CE (V)	CXP (V)
Acetyl fentanyl	323 323	188 105	101 101	10 10	35 57	8 10
Acetyl fentanyl-d_5	328 328	188 105	56 56	10 10	33 61	4 4
Acetyl norfentanyl	219 219	84 136	71 71	10 10	25 27	12 10
Acetyl norfentanyl-d_5	224 224	84 141	66 66	10 10	25 29	4 10

DP = declustering potential; EP = entrance potential; CE = collision energy; CXP = collision cell exit potential.

Its recommendations include: laboratories should develop a comprehensive screening test platform that uses technology such as immunoassays in conjunction with chromatographic techniques; the immunoassay cutoff should be set at a concentration that minimizes false-negative results; tests should be capable of distinguishing between acute and chronic use by analyzing free drug and conjugated drug metabolites; and blood samples should be clearly marked as to the site of collection, with iliac or femoral being preferred sources. The panel noted that the variation in collection sites dramatically complicates interpretation, and too often the term "blood" is used without specifying whether it represents heart (cardiac puncture) blood, subclavian blood, body cavity fluid, or spleen squeeze blood—and is sometimes contaminated with embalming fluid.

The guideline notes that standard practice for forensic toxicology includes:

"1. Identification of the site of specimen collection. If possible, samples should be collected from peripheral blood vessels.

"2. Collection and testing of admission (as opposed to autopsy) blood and urine specimens when applicable and available.

"3. Comprehensive testing for prescription, illicit, and over-the-counter drugs and alcohol.

"4. Testing of appropriate specimens with an emphasis on urine as a means to effectively detect drugs and drug metabolites.

"5. The use of an immunoassay screen with a defined level of sensitivity and supplemental immunoassays for drugs with poor cross-reactivity.

"6. The determination of free and total drug concentrations in blood specimens, at a minimum, and ideally free and individual glucuronide metabolites.

"7. Analysis of free and total opiate/opioid concentrations in other tissues as an adjunct to blood concentrations, where appropriate, or where the blood concentrations may be compromised by postmortem artifact.

"8. Similar standards for cutoff concentrations for confirmatory gas chromatography-mass spectrometry and liquid chromatography-mass spectrometry analysis.

"9. Use of analytical methods that have been appropriately validated and controlled to provide reliable data."

Conclusion

In recent years, U.S. toxicology laboratories have seen a large increase in the use of synthetic drugs. The introduction of fentanyl analogues to a vulnerable population creates a sense of urgency because these new drugs have demonstrated their lethal potential. The moving target of designer drugs illustrates how important and yet difficult it is for toxicology laboratory testing capabilities to keep pace with what seems to be a never-ending variety of synthetic drugs.

Although fentanyl analogues may go undetected in initial toxicology testing, the pathological presentation at the scene and in the autopsy suite may reveal clues as to what type of toxicant a victim ingested. Thus, the guidelines outlined above are strongly recommended as steps toward strengthening the ability to identify opiate-related deaths from either illicit or prescription drug use. Ultimately, proper field investigation combined with comprehensive and technically proficient pathology and toxicology testing should increase communication between facilities and lead to enhanced confidence in the final opinions.

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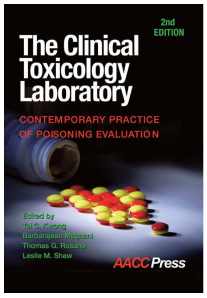
Poisoning Evaluation Update

AACC Press Issues New Edition



The Clinical Toxicology Laboratory: Contemporary Poisoning Evaluation, 2nd Edition
Edited by Tai Kwong, Barbarajean Magnani, Tom Rosano, and Les Shaw
2013, 525 pages, softcover
$124 (AACC members, $99)

This updated edition of a unique textbook on laboratory evaluation of the poisoned patient is written by experts in the fields of laboratory medicine, emergency medicine, and toxicology. The contributors to the book work at poison control centers as well as academic, governmental, and private laboratories. The tome covers a wide range of issues, including the dramatic advances in the care of the poisoned patient, the advent of regional poisoning centers, and the efforts of clinical laboratories to adapt new technologies to support changing diagnostic and treatment modalities.

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Chronic Pain Management

Urine Drug Tests Provide Important Tool in Monitoring Patient Compliance

By Barbarajean Magnani, PhD, MD

A fast-growing epidemic, prescription drug abuse has become the leading cause of unintentional drug overdose deaths in the U.S. (1). Drugs to treat pain have become more commonplace now that pain is considered the fifth vital sign. Most clinicians treat pain with various analgesics, including opioids for chronic noncancer pain.

Noncancer Pain Guidelines and Drug Testing

Guidelines for clinicians who manage pain with opioids recommend using urine drug screens to aid in establishing compliance with the prescription regimen (2). Urine drug tests supplement self-reporting and behavioral monitoring, and can identify problems that would otherwise go undetected. The tests provide an objective measure that can document aberrant drug behavior. Testing can identify the nonuse of prescribed drugs, the use of non-prescribed drugs, and the use of illicit drugs and alcohol.

Tests can help determine whether the patient is adhering to the contract that sets the terms and conditions for chronic opioid therapy. A study by Couto and colleagues that examined more than 900,000 urine samples from patients at a chronic pain clinic underscores the need for testing (3). Using an immunoassay screen with confirmation by tandem mass spectrometry, the researchers found that 11% of the samples were positive for illicit drugs, 29% indicated use of a nonprescribed drug or drugs, and 38% revealed no prescribed drugs.

Immunoassay Limitations

Most initial drugs screens are immunoassays, and despite their usefulness, immunoassays have limitations that many clinicians and even some laboratorians do not appreciate (4). Most clinicians and laboratorians are aware of the need for confirmation testing because immunoassays can be confounded by false-positive or false-negative results.

A point less commonly known is that although many immunoassays are specific for a drug (such as cocaine metabolites and cannabinoid metabolites), many identify only a drug class (such as amphetamines, benzodiazepines, and opiates).

The standard opiates assay targets morphine. Although high concentrations of synthetic and semisynthetic drugs such as hydromorphone, hydrocodone, dihydrocodeine, and oxycodone can also trigger a positive result, lower concentrations of these drugs can go undetected. A positive opiates class assay does not identify which opiate or opioid the patient is taking. A patient taking morphine, codeine, or hydromorphone produces a positive result, but the clinician cannot know whether the patient is taking the prescribed opiate. For example, a patient taking a prescribed dose of the time-release morphine drug, MS Contin (morphine sulfate), produces the same positive opiates result as someone taking codeine, hydromorphone, or even heroin.

One reason for variability in immunoassay results is that cross-reactivity varies by vendor. To circumvent the cross-reactivity problem, some manufacturers have created assays aimed at individual drugs such as buprenorphine, oxycodone, and methadone, but even these assays can lack specificity. For example, despite the buprenorphine assay's low reactivity for morphine (0.010%), the high concentrations from a typical morphine dose can produce a false-positive buprenorphine result, particularly if the test's threshold is set low (such as 5 ng/mL).

Oxycodone is another drug that can confuse a clinician who does not understand the tests' finer points. A clinician who orders a standard opiates screen for a patient on oxycodone may be worried at the lack of a positive result, concerned that either the opiates screen is not working or a patient is diverting the drug, even though the opiates screen is functioning as designed. Conversely, a clinician who orders both a specific oxycodone immunoassay and an opiates screen may not be aware that high concentrations of oxycodone may produce not only a positive oxycodone result but also a positive opiates result.

These examples illustrate the need for laboratorians to provide guides to help clinicians understand which drugs are detected and which are not detected by in-house assays. Table 1 lists the drugs most commonly used for pain control.

Confirmation and Quantitation

Because class immunoassays lack specificity, laboratories must use more sophisticated technologies to confirm positive results and to identify specific drugs. Gas chromatography-mass spectrometry and

Table 1. Drug-Test Targets in Patients Taking Prescribed Opiates

Typical opioids for noncancer chronic pain
Morphine, oxycodone, hydrocodone, hydromorphone, dihydrocodeine, methadone, fentanyl, buprenorphine, oxymorphone, tapentadol
Typical illicit drugs
Amphetamines, benzodiazepines, cannabinoids, cocaine

liquid chromatography-tandem mass spectrometry can typically identify compounds at concentrations of 100 ng/mL or lower. These methodologies can identify not only parent compounds but also major, and sometimes even minor, metabolites.

A minor metabolite that is also a prescription opiate can complicate an interpretation. For example, hydromorphone is a minor metabolite of morphine, so care must be taken to distinguish whether its presence is due to morphine metabolism or abuse of nonprescribed hydromorphone. Determining the relative concentrations of hydromorphone and morphine can help (Table 2).

Some analytical techniques can also identify pharmaceutical impurities produced in the manufacture of some drugs. These impurities can be confusing in the interpretation of the results because one might assume that the patient is taking additional nonprescribed drugs. However, they are usually present in small concentrations compared with the prescribed drug—the quantitation these methods provide can resolve any ambiguity (5).

Consultation

Laboratorians can provide important consultations to physicians caring for patients on chronic opioid medications (6). By explaining the limitations of the assays and suggesting the appropriate confirmation testing or other additional quantitative testing needed, laboratorians can help determine whether the patient is compliant with the prescribed medication regimen.

However, there are limitations with interpretation as well. Although tests can reveal whether patients' urine contains their prescribed medications or metabolites with no nonprescribed or illicit substances, the tests cannot distinguish whether the medications are being taken as prescribed. A positive urine test cannot indicate the amount of drug being taken or the frequency it is being taken. Just the same, the results can reassure a clinician who may be managing very challenging patients.

A laboratory ally can be especially helpful to a clinician reviewing unexpected findings. On occasion, a clinician may be uncertain whether a patient's explanation for an unexpected positive or negative result is scientifically sound. For example, if a patient tries to explain away a positive cocaine metabolite result with the claim of receiving "novocaine" at the dentist, a laboratorian who understands which drugs do and do not cross-react with an assay can provide the guidance to not believe this excuse.

Close collaboration between the laboratory and the clinic is a key to successful management of patients on chronic opioid therapy. By adopting this important consultative role, laboratory medicine physicians and scientists demonstrate their importance as members of the healthcare team who make valuable contributions beyond simply providing numbers.

Table 2. Interpretations of Opiate Concentrations in Patients on MS Contin

Opiate result	*Possible morphine source*
Morphine, 500 ng/mL	Poppy seeds
Morphine, 50,000 ng/mL	MS Contin
Morphine, 50,000 ng/mL and Hydromorphone, 500 ng/mL	MS Contin
Morphine, 50,000 ng/mL and Hydromorphone, 5,000 ng/mL	Ms Contin, Dilaudid

Table courtesy of Tai C. Kwong, PhD

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Disclosure: The author has nothing to disclose.

Continuing Education

Professional Organizations Offer Convenient Online Opportunities

By Michael A. Wagner, PhD, and Donald L. Frederick, PhD

Professional organizations in clinical and forensic toxicology have begun offering on-line programs that make continuing education much more accessible. Many of these programs offer ACCENT® credit, which allows participants to document their continuing education efforts to meet requirements for licensure and certification. Participants can receive certificates to confirm that they have completed the appropriate modules.

The American Association for Clinical Chemistry (AACC) offers two toxicology certificate programs. "Clinical Toxicology" is a basic/intermediate level program for the laboratory scientist. It includes four courses that can be completed online in about two hours each: "Introduction to Clinical Toxicology," "Immunoassays to Screen for Drugs of Abuse," "Specimens for Toxicology Testing," and "Chromatography Basics for Toxicology Testing." Each course contains a lecture, slides, transcripts, and a quiz. Some include additional readings. A discussion board offers the opportunity to interact with faculty and other participants. Successful participants can earn eight ACCENT® credits for completing all four modules.

The "Using Tandem Mass Spectrometry in the Clinical Laboratory" certificate program is composed of nine courses: "Basics of Mass Spectrometry Theory," "Basics of Liquid Chromatography Theory," "Setting up a Clinical Mass Spectrometry Laboratory," "Maintenance and Troubleshooting of Liquid Chromatography-Tandem Mass Spectrometry (LC-MS/MS)," "Making Accurate Calibrators and High Purity Reagents for LC-MS/MS Methods," "Principles and Best Practices for Quantitation Using LC-MS/MS," "Validation of LC-MS/MS Methods," "Tips for Achieving and Maintaining Consistent High Quality Production in a Clinical Mass Spectrometry Laboratory," and "Gas Chromatography-Mass Spectrometry (GC-MS) in Clinical Laboratories."

Each course takes about one to three hours online and contains a lecture, slides, transcripts, and a quiz. Some include additional reading and practice exercises. Discussion boards offer the opportunity to interact with faculty and other participants. The program offers 12 ACCENT credits for successful completion.

More information on these and other programs can be found at http://www.aacc.org/development/certificates/massspeccertprog/pages/default.aspx.

Face-to-Face Education

Of course, the AACC also offers more traditional methods of continuing education. The meeting, "Mass Spectrometry in the Clinical Lab: Best Practices and Current Applications," will feature a presentation or two on toxicology applications. The conference will be held Oct. 9–10 in St. Louis. Julianne Botelho, PhD, of the Centers for Disease Control and Prevention and Deborah French, PhD, of the University of California, San Francisco are helping coordinate this event. More information is available at http://www.aacc.org/events/meetings/Pages/MassSpec-2014.aspx# or from the AACC's David Sainato: Dsainato@aacc.org.

Several AACC webinars this year will address therapeutic drug monitoring and toxicology issues. On April 29, "Mass Spectrometry in Designer Drugs-of-Abuse Testing" will feature Marilyn Huestis, PhD, chief of the chemistry and drug metabolism section of the National Institute on Drug Abuse, discussing advances in LC-MS/MS and GC-MS that can help laboratories keep up with evolving trends in drug abuse. On May 13, "Mass Spectrometry 101" with Thomas Annesley, PhD, professor emeritus of pathology at the University of Michigan, will cover basic principles of this analytical technique. A webinar later in the year on the investigation of poisoning will feature Barbarajean Magnani, MD, PhD, of Tufts Medical Center. For more information on these and other upcoming webinars, visit http://www.aacc.org/events/webinars/pages/default.aspx#.

Other Organizations

Other organizations that provide continuing education for forensic toxicologists include the American Association of Forensic Sciences (www.aafs.org), the Society of Forensic Toxicologists (www.soft-tox.org), the Center for Studies of Law in Action (Borkenstein courses, www.borkensteincourse.org), The Center for Forensic Science Research and Education (www.forensicscienceeducation.org), and RTI International (www.rti.org). RTI provides a number of web-based programs that provide certificates and ACCENT credit.

RTI's programs are supported by the National Institute of Justice and cover a number of forensic topics, including best practices, current advances, classic principles, interpretation, and medical legal testimony. RTI has posted more than 30 courses related to forensic toxicology, with more added continuously. The free-of-charge training modules are

generally about an hour and feature both live presentations and archived courses that can be accessed on-demand in a self-paced format. More information is available at http://www.rti.org/page.cfm/Forensic_Science_Education

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CFTN Readers Are Eligible To Receive ACCENT Credit

Readers of *Clinical & Forensic Toxicology News* are eligible to receive 4.0 ACCENT® credit hours per year (one credit per quarterly issue) of continuing education. ACCENT credit allows you to document your continuing education to meet requirements for licensure or certification.

ACCENT credit is recognized by a wide variety of organizations, including:

- American Association of Bioanalysts
- American Board of Clinical Chemistry
- American Society of Microbiology
- American Society for Clinical Laboratory Science
- American Society for Clinical Pathology
- American Medical Technologists
- Association of Clinical Scientists
- International Federation of Clinical Chemistry
- National Registry in Clinical Chemistry

Learning Objectives

After reading *Clinical & Forensic Toxicology News*, the reader will be able to:

- Describe emerging and changing trends in drug abuse, including new designer drugs, usage patterns, and contaminants/adulterants.
- Identify potential analytes (drugs, metabolites, biomarkers) of clinical and/or forensic significance.
- Evaluate methodologies for their utility and limitations relative to the needs of toxicology labs.
- Explain the analytical and regulatory issues unique to specific applications, including postmortem toxicology, workplace drug testing, and drug screening.

How to Get Credit

After reading this issue's articles, simply access the online evaluation form and print your continuing education certificate: http://direct.aacc.org/customerservice/login.aspx?returnlink=http://apps.aacc.org/applications/apps2/CE/intro.aspx?actNum=2238465

Clinical & Forensic Toxicology News provides practical and timely information on the clinical, forensic, technical, and regulatory issues faced by toxicology laboratories. Each issue includes articles authored by experts.

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