Protocol for Assessing the Potential of Drugs to Impair Driving

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Background

Great Interest in the Magnitude and Scope of the Drug-Impaired Driving Problem

- Many Potentially Impairing Substances
  - Illegal
  - Prescription
  - Over-the-Counter
Need to Know

- Need to determine which drugs
  - Impair driving
  - Increase crash risk
  - Are used by drivers
  - Impairment threshold
  - Effects of combined use of alcohol and drugs
  - Effects of multiple drug use
A Bit of History

- NHTSA and others have been studying this issue for many years
  - Research on how drugs effect driving related skills
    - Laboratory studies of psychomotor tasks
    - Driving simulator studies
    - Closed course studies
    - Open road studies (instrumented vehicles)
  - Progress has been slow
    - Insufficient and inadequate data
    - Conflicting results
    - Large number of potentially impairing substances
The Alcohol Model

• Efforts to eliminate the alcohol crash problem have spanned more than 60 years

• Considerable progress has been made
  - In the US:
    • 1960’s some 50% of fatal crashes involved alcohol
    • Now down to 30%

• With almost 13,000 A/R deaths we have a long way to go
What it Took to Get Where We are Today

• Evidence that alcohol impairs driving related skills
  - Laboratory studies
  - Simulator studies
  - Instrumented vehicle studies

• Evidence about impairment threshold
  - Impairment starts with the first drink
  - Dose – Response relationship

• Evidence that alcohol raises the risk of crashing
  - Case-Control studies to estimate crash risk at various BACs
Alcohol Relative Risk Estimate

Relative Crash Risk (BAC 0.00 = 1.0)

BAC Level
The List

• Drugs drivers should not use and drive
• Drugs drivers can use safely

Example: NTSB Recommendation (January 2000):

• Develop, with assistance from experts on the effects of pharmacological agents on human performance and alertness, a list of approved medications and/or classes of medications that may be used safely when operating a vehicle.
Drug Use and Driving Impairment

• Some drugs have been shown to impair driving related skills
  - Laboratory, simulator, instrument vehicles (closed course and on-road studies)
  • Physiological, behavioral, cognitive
People Drive After Using Drugs

• Drivers use drugs
  – Anecdotal
  – Expert opinion
  – Tests for drug use:
    • Arrested drivers
    • Injured drivers
    • Fatally injured drivers
  – DRUID Epidemiological Study
  – US 2007 National Roadside Survey
Case Study: Marijuana

• Many studies have looked at marijuana
  – Evidence is quite mixed
    • Does marijuana impair driving?
      – Most studies find impairment, some do not
    • Does marijuana increase crash risk?
      – Evidence is split
        » Reduced risk
        » No effect
        » Increased risk
The Threshold Issue

- Evidence about dose response relationship
  - Impairment thresholds?
  - Do higher blood levels mean greater impairment?

- For some/many drugs there is no linear correlation
  - Peak blood levels do not correspond to peak impairment and vice-a-versa
Other Challenges

- Adaptation (habituation)
- Sensitivity
- Acute effects versus chronic use (steady state)
- Individual differences
- Lack of standardization in research methods
Lack of Standardization in Research Methods

• Comparing outcomes of different studies
  – Using different procedures
  – Different subjects
  – Different dosages
  – Different outcome measures
  – Often produce different outcomes!
Need for a Standard Protocol for Testing Whether Drugs Impair Driving

First Step:

• Assembled a multidisciplinary panel of experts to determine how one might establish a protocol for determining whether a particular drug impairs driving

• Representatives from federal agencies with interests in, or knowledge of the methods related to the study of drugs and driving
  - CDC—Dr. Ann Dellinger
  - NIAAA—Dr. Ralph Hingson
  - NIDA—Dr. Steve Gust
  - SAMHSA—Mr. Steve Wing
  - NTSB—Dr. Mitch Garber
  - NHTSA
Establish DUID

Expert Panel: Fields Represented

Expert Panel – Fields Represented:

- Epidemiology
- Toxicology
- Pharmacology
- Behavioral Science
  - Experimental Psychology
  - Neuropsychology
- Occupational Medicine
- Other Traffic Safety Professionals
Panel Members

- Dr. Gary G. Kay, Cognitive Research Corporation, Panel Chair
- Dr. Douglas Beirness, Canadian Centre on Substance Abuse
- Dr. Barry K. Logan, DABFT, NMS Labs
- Dr. Herbert Moskowitz, University of California, Los Angeles
- Dr. Jan Ramaekers, Maastricht University, the Netherlands
- Dr. Lionel Raymon, Miller School of Medicine, University of Miami
- Dr. Gordon S. Smith, University of Maryland School of Medicine,
- Dr. Loren Staplin, TransAnalytics, LLC

- Federal agencies attending—FDA, FMSCA, ODAPC
Determining the Potential of Drugs to Impair Driving

NHTSA’s question for the expert panel:

- Can a protocol be developed to determine which drugs or classes of drugs may pose a hazard to drivers, or others in safety-sensitive transportation roles?
  
  • This includes illicit and licit (prescription and over-the-counter) drugs
Prior Efforts

• ICADTS
• Talloires Group
• DRUID
• Others

However, these efforts were based on Clinical Judgment, not:
  - Data driven
  - Evidence based
Panel Conclusions

• Some drugs have limited potential to impair driving
• Other drugs are clearly at high risk of impairing driving:
  – Sedatives
  – Hypnotics
  – Sedating antihistamines
  – Narcotic analgesics
  – Hallucinogens
  – Antipsychotics
  – Muscle Relaxants
Conclusions

• Many drug classes it is not possible to define the risk for driving
  – Insufficient evidence
  – Effects highly dose-dependent
  – Heterogeneity within drug class
  – Tolerance effects
  – E.g.
    • Serotonin reuptake inhibitor (SSRI) antidepressants
    • Anticonvulsants
    • Antihypertensives
A Barrier to Classifying Drug Effects on Driving

- Lack of a common, standardized protocol for assessing the impairing potential of drugs
- For most drugs behavioral effects have not been studied systematically
  - Inconsistent testing methods
  - Varied research protocols
    - Dose
    - Time since dosing
    - Chronicity of use
    - Varied dependent measures
Need for Structured and Standardized Protocol for Assessing Driving Impairment Risk

• Effective assessment methodologies currently are available that could be incorporated into a standardized protocol for assessing driving impairment risk

• Standardization would allow
  – Inter-study comparison
  – More uniform reporting of results

• This standardized protocol would take the form of a tiered, parallel process involving pharmacological, toxicological, epidemiological testing or reviews and standardized behavioral assessment
Tiered Assessment Protocol

• The tiered approach recognizes that some drugs can be easily determined not to represent much risk for driving and would not undergo the entire assessment protocol.
• Potentially impairing drugs may be identified in various ways:
  - Pharmacology or toxicology
  - Epidemiology
• Drugs identified as potentially impairing would undergo the full assessment protocol to better gauge the actual risk they present.
Interrelation of the pharmacological/toxicological, epidemiological and behavioral assessments proposed by the panel

**Pharmacology/Toxicology Review**
- Receptor chemistry
- Pharmacokinetics and pharmacodynamics
- Adverse event profile
- Drug-drug interactions
- Impairment associated same-class drugs
- Toxic effects and overdose
- Drug interactions (metabolic and behavioral)
- Drug concentrations associated with impairment

**Epidemiology Review**
- Over-representation of drug in crash-risk statistics
- High relative risk for crashes for drug or drug class
- High prevalence of drug in multi-national studies
- Rates of detection in high risk populations

**Standardized Behavioral Assessment**
- Neuropsychological testing
- Alertness/arousal
- Attention & processing
- Reaction time /psychomotor functioning
- Sensory-Perceptual Functioning
- Executive Functions
- Driving Simulation testing
- Over-the-road testing
Pharmacological and Toxicological Review

- Pharmacological
  - Receptor chemistry
  - Pharmacokinetics
  - Pharmacodynamics
  - Main effects
- Toxicological
  - Adverse events
  - Abuse
  - Overdose
  - Drug interactions
Epidemiological Review

- Prevalence data on drug use by drivers
- Over-representation of certain drugs in crashes
- Relative risk of impairment for different drugs/dosages
  - Comparison to control populations
  - Culpability assessment
- Multiple drug use and crash involvement
Behavioral Assessment

- Objective: To evaluate drugs with respect to likelihood of impairing selected driving-related skills.
- Key definitions:
  - **Impairing**: decline in performance which increases the likelihood of a crash or which has a significant impact on driving safety
  - **Driving related skills**: the cognitive, perceptual and motor abilities that are critical (or essential) to the task of driving
Assumption

- A test battery comprised of tests of the cognitive, perceptual, and motor abilities required to perform the task of driving, which provides a reliable and valid assessment of the levels of these required abilities, is capable of identifying those changes or levels of performance which are associated with increased crash risk.
Behavioral Domains Relevant to Driving

- **Alertness / Arousal**
  - Ranges from fully alert and awake to somnolence, stupor and coma
  - Decreases in alertness are associated with impaired vigilance, weaving, and falling asleep while driving
  - Behavioral measures
    - Performance tests (e.g., vigilance tests)
    - Driving measures (e.g., instrumented vehicle)
    - Self-report measures
Behavioral Domains Relevant to Driving

• **Attention and Processing Speed**
  - Multiple facets of attention play a role in driving: focused or selective attention; sustained attention or vigilance; divided attention; shifting or alternating attention; and working memory or concentration
  - Information processing speed refers to the rate at which information is perceived and responded to
  - Behavioral measures
    • Performance tests (e.g., working memory, vigilance, divided attention)
    • Driving tests (e.g., simulator, instrumented-vehicle)
    • Self-report measures
Behavioral Domains Relevant to Driving

• **Reaction Time / Response Time**
  - The rate at which activities are performed which is a function of perceptual speed, response selection, and speed of motor response.
  - Perceptual speed and response selection are key variables in the total response time for vehicle control actions.
  - Behavioral measures
    • Performance tests (e.g., choice reaction time, measures of perceptual speed)
    • Driving tests (e.g., brake reaction time in simulator or instrumented-vehicle)
Behavioral Domains Relevant to Driving

• Sensory-Perceptual Functioning
  - Sensory abilities (visual, auditory, proprioceptive and sensorimotor) required to perceive vehicle and roadway conditions.
  - Behavioral Measures:
    • Visual scanning behavior
    • Tunnel vision
    • Contrast sensitivity
Behavioral Domains Relevant to Driving

• **Executive Functions**
  - Capacities involved in planning, approaching, organizing, monitoring, and carrying out various cognitive activities. Includes ability to control one’s behavior (e.g., suppress impulses) and use good judgment.
  
  - Behavioral measures
    • Performance tests (e.g., mental flexibility, adaptive problem solving, impulse control, planning, and organization)
Test Criteria for Inclusion in the Behavioral Protocol

Requirements for tests to be included in the test battery:

• Test assesses an ability that is critical for safe driving

• Test is known to be sensitive to drug effects
  – test is known to be sensitive to effects of drugs of abuse and/or pharmaceuticals
  – preferably sensitivity is expressed in terms of the power of the test to detect a specified level of change
Test Criteria for Inclusion in the Behavioral Protocol

• Tests should be administered as part of a comprehensive test battery that fully characterizes the abilities that may be impaired by a drug

• Measures of sustained attention must be of sufficient duration to detect lapses of attention

• Tests must be suitable for repeated administration

• Tests must be standardized, reliable, and valid measures of target abilities
Driving Tests

• Panel recommended inclusion of assessments of impairment through the use of
  – Driving simulators
  – Closed course driving tests
  – Over-the-road driving tests
  – Instrumented vehicles

• Very little standardization in many of these tests – as a result these tests play a limited role in the tiered assessment protocol
Next Steps

• Validation of this tiered assessment protocol
• Panel recommended:
  - Apply process to a small number of drugs from classes known to present driving impairment risk
    • Opiates, Cocaine, Amphetamines, and Barbiturates
  - Test medications at doses representing the full therapeutic range
  - Test both acute and steady-state dosing effects
  - At relevant time intervals post-dosing
  - Test at peak serum levels and times known or suspected to be associated with maximum impairment

NHTSA
www.nhtsa.gov
Next Steps

- Include a representative sample of target population
- While individual tests are presumed to have been validated, empirically validate the test battery as a whole
  - Examine inter-correlations between tests
  - Determine convergent and discriminant validity of the measures

On the web at:

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Questions?
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