Improving Identification of Drugged Driving Collisions and Injuries Using Multiple Data Sources

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EXECUTIVE SUMMARY

- The 2014 FARS file included toxicology results for 75% of fatally injured motor vehicle drivers, compared to 12% for the 2014 CRASH file.
- Toxicology results in FARS indicate that 38% of fatally injured motor vehicle drivers tested positive for at least one substance in 2014.
- Drug concentration levels are not reported on FARS.
- The Kentucky Electronic Death Reporting System (KY-EDRS) provides an opportunity for increasing the capture of post-mortem toxicology findings, including drug concentration levels, at the point where the coroner certifies the cause of death.
- In 2014, post-mortem toxicology findings were documented in KY-EDRS for approximately 5% of fatally injured drivers.
- For motor vehicle drivers treated at the University of Kentucky trauma hospital in 2014 following involvement in a traffic crash in Kentucky, at least 17% - and possibly as many as 30% - had a positive toxicology finding for at least one drug on the trauma registry record. These results are suggestive of drugs present at the time of the crash, even after accounting for medications known to have been administered to the patients as part of medical treatment. This finding compares favorably to the 38% of fatally injured drivers with positive drug findings in FARS, and the 22% of ALL drivers testing positive for drugs in the 2013-2014 NHTSA roadside survey.
- The ICD-9-CM code 305, for “nondependent abuse of drugs,” shows promise as a proxy for identifying additional cases of drug intoxication in hospital billing data that are not documented in the CRASH system. However, our findings also suggest that this code will be present on the hospital billing record in only a small percentage of all true cases of driver drug impairment.

BACKGROUND

It is widely acknowledged that drugged driving statistics based on police accident reports (PAR) underrepresent the true incidence of traffic injuries involving drivers under the influence of drugs. A recent study of fatally injured drivers in the Fatality Analysis Reporting System (FARS) files for 1999-2010 reported that, in 6 states that routinely perform toxicological testing on drivers involved in fatal crashes, 24.8% tested positive for drugs (Brady 2014). Of those drivers, 12.2% tested positive for marijuana and 5.4% tested positive for opioids. The proportion of fatally injured drivers testing positive in those 6 states increased from 16.6% in 1999 to 28.3% in 2010. The states included in the study were California, Hawaii, Illinois, New Hampshire, Rhode Island and West Virginia.

Kentucky PAR records from the Collision Report Analysis for Safety Highways (CRASH) system indicate suspicion of drug impairment for between 1% and 5% of fatally injured drivers from 2000 to 2014. By comparison, FARS records indicate a positive test result for drugs for 16% to 37% of drivers fatally injured on Kentucky road over the same time period (Table 1). The reason for the difference is that CRASH information on drug involvement is based, in most cases, on the impression of the investigating officer, whereas FARS results are based on post-mortem toxicology (PMT) test results obtained from a variety of sources.

Table 1. Percent of fatally and nonfatally injured drivers in Kentucky crashes with suspected drug impairment on CRASH, and percent of fatally injured drivers with positive drug test result on FARS

Year	Fatally injured drivers with suspected drug impairment - CRASH	Nonfatally injured drivers with suspected drug impairment - CRASH	Fatally injured drivers with positive drug test result per PMT screen - FARS
2014	5%	2%	37%
2013	3%	2%	35%
2012	4%	2%	33%
2011	5%	2%	38%
2010	3%	2%	31%
2009	4%	2%	31%
2008	3%	2%	32%
2007	1%	2%	30%
2006	3%	2%	27%
2005	3%	2%	23%
2004	3%	2%	16%
2003	2%	1%	16%
2002	2%	1%	17%
2001	3%	1%	13%
2000	1%	1%	16%

Kentucky CRASH records also report that between 1% and 2% of nonfatally injured drivers (according to police-reported injury status) were suspected of drug impairment from 2000 to 2014. However, national surveys suggest that the true percentage may be higher. According to the 2013 National Survey on Drug Use and Health (NSDUH), an estimated 3.8 percent of persons aged 12 or older self-reported driving

under the influence of illicit drugs during the previous year. ("Illicit drugs" in the NSDUH refers to illegal drugs, including marijuana according to federal law, and misuse of prescription drugs.) *Note that this is 3.8% of all drivers who responded, not only those who were involved or injured in a traffic crash*. The NHTSA National Roadside Survey (NRS) found that > 22% of consenting drivers tested positive for illegal, Rx or over-the-counter drugs (Berning et al. 2015). Of course, in the case of the NRS, the presence of drugs does not necessarily imply impairment. Nevertheless, these two survey results taken together suggest that the actual percentage of nonfatally injured drivers with drug impairment is higher than the 1% to 2% captured by CRASH.

Project Aims

With support from NHTSA's Crash Outcome Data Evaluation System (CODES) program and Section 405/408 traffic records improvement grants from the Kentucky Office of Highway Safety, KIPRC has previously linked CRASH records with several injury databases. The goal of this project was to improve the completeness of drugged driving data on Kentucky's linked CODES files for 2010-2014. Our approach was to consolidate information on drug involvement captured in injury surveillance databases that have been linked with CRASH, including FARS, hospital inpatient claims records, emergency department claims records, and trauma registry records. Our specific aims were as follows.

1. Assess Capture of PMT Drug Test Results on FARS and KY Death Certificates

Utilizing previously linked CRASH, FARS and Kentucky death certificate (KDC) records for 2010-2014, we assessed the reporting of drug test results in each data system.

2. Assess Capture of Information on Drug Impairment In Trauma Registry and Hospital Billing Data Systems

Assess drug test results in KY trauma registry

In 2014, all Kentucky trauma facilities submitting data to the state trauma registry began submitting data on toxicology/drug screen results. Facilities also began submitting information on medications administered as part of the patient's care (on the scene, enroute, or at a referring facility) that may influenced drug screen results. With this information, it should be possible to distinguish between positive toxicology findings that indicate drugs present at the time of the collision, from those that resulted from drugs administered post-crash for medical purposes.

Using previously linked CRASH and trauma registry files for 2014, we assessed drug test results reported on trauma registry records, and compared trauma registry drug findings with those reported on CRASH.

Assess drug impairment data in KY hospital billing files

In Kentucky, it has been shown using linked CRASH and hospital/emergency department billing records, that some drivers who are hospitalized following a traffic crash have a diagnosis of nondependent abuse of drugs (305) on their hospital record but no indication of drug suspicion on their CRASH record (Bunn et al. 2013). This suggests that linked CRASH and hospital/ED records might be used to identify additional cases of drugged driving. Using linked trauma registry and hospital billing records for 2014, we assessed the validity of the 305 ICD-9-CM code as in indicator of the presence of drugs in the patient, using toxicology findings reported in the trauma registry as the gold standard.

METHODS

Assess Capture of PMT Drug Test Results on FARS and KY Death Certificates

CRASH, FARS and Kentucky death certificate (KDC) records for 2010-2014 were linked under a previous traffic records improvement grant. We used 2014 data from that linked database to assess reporting of drug test results in each data system.

CRASH Data

Suspicion of drug involvement was based on the "drug involvement" code under "human factors." Driver drug test was based on evidence that a test sample was actually obtained and submitted for testing, as indicated by the variables "Chemical Test Offered," "Test Refused," "Location Where Sample Submitted,"; and "Test Results." Specific toxicological findings were extracted from "Test Results," which is an unstructured text string.

FARS Data

Driver drug testing was determined based on the variables DSTATUS (Drug Test Status). Specific toxicological findings were determined based on variables DRUGRES1, DRUGRES2 and DRUGRES3 (Drug Results).

Kentucky Death Certificate (KDC) Data

We scanned death certificate literal text for mentions of drug names in the cause of death section (Part I, lines A through D, and Part II) or the injury description section. Scanning was done using an algorithm created by the Council for State and Territorial Epidemiologists (http://www.cste.org/blogpost/1084057/211072/Epi-Tool-to-Analyze-Overdose-Death-Data). We also searched for the following ICD-10 codes for drug poisoning and drug intoxication in the underlying and contributing cause of death codes.

- T36-T50 - Acute drug poisoning
- F11.0 - Opioid intoxication
- F12.0 - Cannabinoid intoxication
- F13.0 - Sedative/hypnotic intoxication
- F14.0 - Cocaine intoxication
- F16.0 - Hallucinogen intoxication
- F18.0 - Solvent intoxication
- F19.0 - Intoxication by other psychoactive substances

Assess Capture of Information on Drug Impairment in Trauma Registry and Hospital Billing Data Systems

Assess drug test results in KY trauma registry

Drug test results captured in the KY Trauma Registry were assessed using the trauma registry data file for 2014, which had been previously linked to the 2014 KY CRASH file. From that linked data set we selected only trauma registry cases that matched to a CRASH record.

The variable “Drug Use Indicator” was used to determine whether a patient was tested, and the findings (no substances detected; positive for Rx drugs positive for illegal drugs; positive for Rx and illegal drugs). Up to 25 specific toxicology findings may be listed on the trauma registry record; specific drug screen results that could be listed in 2014 are:

Toxicology Drug Codes

AMPH	AMPHETAMINES
BARB	BARBITURATES
BENZ	BENZODIAZEPINES
COC	COCAINE
LSD	LSD
MARI	MARIJUANA/THC/CANNABINOIDS
METH	METHAMPHETAMINES
OPI	OPIATES
PCP	PCP/PHENCYCLIDINE
TRIC	TRICYCLIC ANTIDEPRESSANTS
INHAL	INHALANTS
METHD	METHADONE
OXY	OXYCONTIN
NOT	NOT DOCUMENTED
NA	NOT APPLICABLE

Interpretation of toxicology results for trauma patients is complicated by the fact that some common medications of abuse – most notably opiates and benzodiazepines – are also frequently administered to trauma patients in the course of their treatment. The trauma registry also allows reporting of up to 25 medications that were administered to the patient, and the location where the medication was administered. The allowable medication codes and locations are listed in the following tables.

Medication Codes

ETOM	ETOMIDATE/AMIDATE
FEN	FENTANYL/DURAGESIC
KET	KETAMINE
MS	MORPHINE/MS CONTIN
METHD	METHADONE
HYDROC	HYDROCODINE/LORTAB
DEM	DEMEROL/MEPERIDINE
ATIV	ATIVAN/LORAZEPAM
VALIUM	DIAZEPAM/VALIUM
PROP	PROPOFOL/DIPRIVAN
VERS	VERSED/MEDAZOLAM
DILAD	DILAUDID/HYDROMORPHONE
XANAX	XANAX/ALPRAZOLAM
ELAVIL	AMITRIPTYLINE/ELAVIL

VEC	VECURONIUM
ROC	ROCURONIUM
SUCC	SUCCINYLCHOLINE
OTHER	OTHER MEDICATION
NA	NO MEDICATIONS
NOT	NOT DOCUMENTED

Medication Location Code

SCENE	ADMINISTERED AT SCENE
REF	ADMINISTERED AT REFERRING FACILITY
ED	ADMINISTERED IN EMERGENCY DEPARTMENT
FLOOR	ADMINISTERED ON FLOOR
OR	ADMINISTERED IN OPERATING ROOM
ICU	ADMINISTERED IN ICU
OTHER	ADMINISTERED IN OTHER LOCATION
NA	NOT APPLICABLE
NOT	NOT DOCUMENTED

Not all hospitals reported information on medications administered in 2014. Moreover, if a medication was reported to have been administered in the emergency department (ED) (of the reporting/testing trauma facility), it is not possible to determine whether the drug test sample was drawn before or after the medication was administered in the ED.

For these reasons, **we conducted a separate analysis of toxicology findings for drugs that are not used in the treatment of trauma patients**. For the analysis of toxicology findings for opiates and benzodiazepines, we created a mapping of medications to the toxicology finding that they would trigger, as follows. (These mappings were verified with the Trauma Registrar and Chief Laboratory Technologist at the University of Kentucky Hospital.)

- Fentanyl, Morphine, Methadone, Hydrocodone, Demerol, Dilaudid → Opiate
- Ativan/Lorazepam, Valium/Diazepam, Versed/Medazolam, Xanax/Alprazolam → Benzodiazepine

Positive toxicology findings for opiates or benzodiazepines, for which there was any mention of one of these administered medications, were considered inconclusive for the purpose of assessing driver impairment.

Assess drug impairment data in KY hospital billing files

Toxicology results on trauma registry records provide an opportunity to assess the use of hospital billing data for identifying drug impairment. We linked trauma registry records for 2014 to hospital inpatient and emergency department records for 2014, and used the resulting linked data set to evaluate the use of the ICD-9-CM diagnostic code 305 ("nondependent abuse of drugs") as an indicator of the presence of drugs in the patient on hospital records, using toxicology findings reported in the trauma registry as the ground truth. Table 2 presents ICD-9-CM codes used to identify drug mentions in hospital billing records, for cases having a positive drug test result in the trauma registry record.

Table 2. ICD-9-CM codes used to identify drug mentions in hospital billing records, for selected drug types from trauma registry toxicology

	Acute Poisoning		Adverse Effects in Therapeutic Use	Nondependent Abuse	
Drug Type	Specific Drug (N)	Unspecified drug (N)		Specific Drug (N)	Unspecified drug (N)
Marijuana	No ICD-9-CM codes for marijuana poisoning	977.9, E858 (.8,.9), E950.5, E962.0, E980 (.4, .5)	E939.6	305.20 – 305.22	305.90 – 305.92
Cocaine	304 (.20-.22), 305 (.60-.62), 760.75, 968.5, 970.81, E854.3, E855.2, E938.5	977.9, E858 (.8,.9), E950.5, E962.0, E980 (.4, .5)	E940.8	305.60 – 305.62	305.90 – 305.92
Methamphetamine	304 (.40-.42), 305 (.70-.72), 969.7, E854.2, E939.7	977.9, E858 (.8,.9), E950.5, E962.0, E980 (.4, .5)	-	305.70 – 305.72	305.90 – 305.92
Amphetamine	304 (.40-.42), 305 (.70-.72), 969.7, E854.2, E939.7	977.9, E858 (.8,.9), E950.5, E962.0, E980 (.4, .5)	E940.9	305.70 – 305.72	305.90 – 305.92
Barbiturate	967.0, E937.0, E851-E853, E854 (.0-.2,.8), E855.0, E950 (.1-.3) E980 (.1-.3)	977.9, E858 (.8,.9), E950.5, E962.0, E980 (.4, .5)	E937.0	305.40 – 305.42	305.90 – 305.92
Methadone	965.02, E850.1, E935.1	977.9, E858 (.8,.9), E950.5, E962.0, E980 (.4, .5)		305.50 – 305.52	305.90 – 305.92
Any of the Above	-	977.9, E858 (.8,.9), E950.5, E962.0, E980 (.4, .5)	E947.9	-	305.90 – 305.92

RESULTS

Drug Involvement in Fatal Crashes

CRASH

Previously we linked CRASH, FARS and KY Death Certificate (KDC) files for 2010-2014. For this drugged driving analysis, we selected motor vehicle drivers killed in crashes that occurred in 2014. The 2014 FARS file identified 668 motor vehicle traffic fatalities. Of these, we were able to link 606 (91%) to both a FARS record and a KDC record. (Note: KDC includes deaths of Kentucky residents that occur out of state, and may not include deaths of persons involved in traffic crashes in Kentucky but who died in other states – for example, those who were transported to a hospital outside Kentucky for medical treatment. Thus, KDC captures a somewhat different population of traffic crash decedents than CRASH and FARS capture).

Because the focus of this project was to compare drug impairment information captured on these three data sources, we selected as the study sample the 606 drivers for which records could be identified in all three sources.

Table 3. characterizes the study sample, which included 428 motor vehicle drivers (71%), 124 motor vehicle passengers (20%), 50 pedal cyclists (8%) and 4 others (1%). Seventy percent of decedents were male, 92% were Caucasian, and 97% were non-Hispanic. Seventy-six percent of decedents were occupants of cars and light trucks, 13% were motorcyclists, 8% were pedal cyclists and 3% were other types.

Table 3. Description of sample of N=606 persons killed in traffic fatalities in 2014, for which matching FARS and KY Death Certificate records were identified

Characteristic	Number	Percent
Person Type		
Driver	428	70.6%
Non-driver		
Passenger	123	20.3%
Pedestrian	50	0.0%
Bicyclist	3	8.2%
Other type	2	0.6%
Gender		
Male	426	70.3%
Female	180	29.7%
Race		
Caucasian	556	91.7%
African-American	33	5.4%
Other race	17	2.8%
Ethnicity		
Hispanic	18	2.9%
Non-Hispanic	588	97.0%
Age		
<16	20	3.3%
16-24	131	21.6%

Characteristic	Number	Percent
25-44	191	31.5%
45-64	163	26.9%
65+	101	16.6%
Vehicle Type		
Car	333	54.9%
Light truck	125	20.6%
Heavy truck	9	1.4%
Motorcycle	78	12.8%
Pedestrian	50	8.2%
Bicyclist	3	0.5%
Other type	8	1.3%

Tables 4-6 summarize the information on drug impairment captured on the CRASH, FARS and KDC records for these 606 cases. In Table 4, drugs were mentioned as a contributing crash factor for 4.4% of motor vehicle drivers on the CRASH file. Drug tests were reportedly administered for 12.4% of drivers. Only **1.6% of drivers had a positive drug test result mentioned on the CRASH file**. Test results were listed as "Pending" for more than half of motor vehicle drivers who were tested (31/58 = 53%).

Table 4. Drug impairment information captured on CRASH records for N=606 persons

	Drivers (N=428)		Non-Drivers (N=178)	
Variable	**Number**	**Percent**	**Number**	**Percent**
Suspected of Driving Under the Influence of Drugs or Alcohol				
Yes	74	17.3%	0	0.0%
No	353	82.5%	0	0.0%
Missing	1	0.2%	178	100.0%
Drugs Listed as Possibly Contributing to Crash				
Yes	19	4.4%	9	5.1%
No	409	95.6%	169	94.9%
Test Offered[1]				
Yes	58	13.6%	0	0.0%
No	369	86.2%	0	0.0%
Missing	1	0.2%	178	100.0%
Test Method				
Blood	41	9.6%	0	0.0%
Blood and Urine	15	3.5%	0	0.0%
Other	2	0.4%	0	0.0%
Missing	370	86.5%	178	100.0%
Tested For				
Alcohol	5	1.2%	0	0.0%
Drugs	3	0.7%	0	0.0%
Alcohol and Drugs	50	11.7%	0	0.0%
Missing	370	86.4%	178	100.0%
Test Results[2]				

Positive for Alcohol	16	3.7%	0	0.0%
Positive for Drugs	7	1.6%	0	0.0%
Negative	3	0.7%	0	0.0%
Pending	31	7.2%	0	0.0%
Unknown results and others	4	0.9%	0	0.0%
Missing	370	86.4%	178	100.0%

[1] Indicates whether a drug test was documented on the CRASH report. A value of 'No' does not necessarily imply that a drug test was not conducted.

[2] Some decedents tested positive for both alcohol and drugs; counts to not sum to 428

In Table 5, whereas CRASH reported a drug test for 12.4% of the 428 motor vehicle drivers, **FARS reported a drug test for 75% of drivers**. This difference is due to two main factors. First, the number of drug tests requested by law enforcement may be underreported; and second, the FARS analyst attempts to gather drug test results from a variety of sources, including Axis Forensic Toxicology (AFT), the KY State Police laboratory, county coroners and local law enforcement agencies. Based on personal communication, the majority of drug test results that are obtained are recovered from AFT.

Moreover, whereas 1.6% of motor vehicle drivers had a positive drug test result reported in CRASH, 164 out of 428 **(38%) had a positive drug test result reported in FARS**. **Narcotics** (17% of all motor vehicle driver decedents) and **cannabinoids** (16% of all motor vehicle driver decedents) were the most commonly reported drugs. Depressants were reported in 13% of drivers, and stimulants in 5%.

Table 5. Drug impairment information captured on FARS records for N=606 decedents

	Drivers (N=428)		Non-Drivers (N=178)	
	Number	**Percent**	**Number**	**Percent**
Drug Test Results Obtained[1]				
Yes	319	74.5%	103	57.9%
No	98	22.9%	74	41.6%
Missing	11	2.6%	1	0.5%
Test Method				
Blood	41	9.6%	0	0.0%
Blood and Urine	15	3.5%	0	0.0%
Other	2	0.4%	0	0.0%
Missing	370	86.5%	178	100.0%
Test Results				
Not tested	98	22.9%	74	41.6%
Positive	164	38.3%	49	27.5%
Negative	156	36.5%	54	30.3%
Unknown	3	0.7%	0	0.0%
Missing	7	1.6%	1	0.6%
Specific Drugs Identified[2]				
Narcotic	72	16.8%	15	8.4%
Cannabinoid	67	15.7%	26	14.6%
Depressant	55	12.9%	15	8.4%
Stimulant	22	5.1%	7	3.9%

Other drugs	19	4.4%	1	0.6%
Hallucinogen	1	0.2%	0	0.0%

[1] 'No' indicates that a drug test result could not be obtained; it does not necessarily indicate that a drug test was not administered.

[2] A decedent having drugs identified in more than one category will appear in all identified categories; percentages under this heading do not sum to 100%.

In Table 6, the key finding is that only **20 (4.7%) motor vehicle driver decedents had any mention of drug involvement on the death certificate record**. There were 19 (4.4%) with at least one drug name mentioned in the unstructured text fields for cause of death and injury description. Moreover, there were 5 (1.2%) with at least one ICD-10 code for acute poisoning (T36-T50) or drug intoxication (see Methods for specific codes scanned) mentioned among the structured (underlying and contributing) cause of death variables on the death certificate record. (In fact, there were no mentions of drug intoxication codes identified; all identified mentions were drug poisoning codes). Four decedents had both, for a total of 20 with any mention of a drug on the death record.

Table 6. Drug information captured on KY Death Certificate records for N=606 decedents

	Drivers (N=428)		Non-Drivers (N=178)	
Free Text Drug Name Mentions[1]	**Number**	**Percent**	**Number**	**Percent**
Opioids	8	1.9%	*	-
Cannabinoids	6	1.4%	*	-
Stimulants	6	1.4%	*	-
Depressants	*	-	*	-
"Substance" or "Medication"	*	-	0	0.0%
Any mention of drug in free text	19	4.4%	5	2.8%

[1] Opioids includes "Hydrocodone","Methadone","Heroin"; Cannabinoids includes "Cannabinoids" ,"Tetrahydrocannabinol"; Stimulants includes "Amphetamine","Cocaine","Methamphetamine","Pseudoephedrine"; Depressant includes "Alprazolam","Barbiturates". Note that these are not the only keywords scanned for by the algorithm we used; they represent only the keywords that were actually identified in the text. If a decedent had a drug from more than one drug mentioned, they were included in the count for each category. Percents do not sum to 100%.

Assess Drug Test Results in KY Trauma Registry

Data Sample

From the 2014 linked CRASH and trauma registry data file, we identified 1,838 patients who were treated at a Kentucky trauma hospital following involvement in a traffic crash in Kentucky. Table 7 describes the characteristics of the patients in the sample.

Table 7. Characteristics of N=1,838 patients treated at a Kentucky trauma hospital following involvement in a traffic crash in Kentucky

Characteristic	Number	Percent
Person Type		
Driver	1,222	66.49%
Non-driver		
Passenger	420	22.85%
Vehicle occupant	0	0.00%
Pedestrian	169	9.19%
Other type	1	0.05%
Bicyclist	26	1.41%
Gender		
Male	1,078	58.65%
Female	760	41.35%
Race		
Caucasian	1,668	90.75%
African-American	135	7.35%
Other race	25	1.36%
Ethnicity		
Hispanic	16	0.87%
Non-Hispanic	1,766	96.08%
Age		
<16	126	6.86%
16-24	336	18.28%
25-44	565	30.74%
45-64	522	28.40%
65+	289	15.72%
Vehicle Type		
Car	836	45.48%
Light truck	513	27.91%
Heavy truck	27	1.47%
Motorcycle	245	13.33%
Other vehicle	22	1.21%
Pedestrian	169	9.19%
Bicyclist	26	1.41%

Sixty-six percent of patients in the sample were motor vehicle drivers, 23% were motor vehicle passengers, 9% were pedestrians, and 1.4% were bicyclists. Fifty-nine percent were male, 91% were

Caucasian, and 96% were non-Hispanic. Seventy-three percent were occupants of a car or light truck and 13% were motorcyclists.

Table 8. Drug impairment information captured on CRASH records for N=1,838 crash participants treated at a Kentucky trauma hospital following involvement in a traffic crash in Kentucky

	Drivers (N=1,222)		Non-Drivers (N=616)	
Variable	**Number**	**Percent**	**Number**	**Percent**
Suspected of Driving Under the Influence of Drugs or Alcohol				
Yes	134	11.0%	0	0.0%
No	1,088	89.0%	0	0.0%
Missing	0	0.0%	616	100.0%
Drugs Listed as Possibly Contributing to Crash				
Yes	43	3.5%	18	2.9%
No	1,179	96.5%	598	97.1%
Test Offered[1]				
Yes	106	8.7%	0	0.0%
No	1,116	91.3%	0	0.0%
Missing	0	0.2%	616	100.0%
Test Method				
Blood	101	8.3%	0	0.0%
Blood and Urine	7	0.6%	0	0.0%
Missing	1,121	91.7%	616	100.0%
Tested For				
Alcohol	28	2.3%	0	0.0%
Drugs	20	1.6%	0	0.0%
Alcohol and Drugs	58	4.7%	0	0.0%
Missing	1,116	91.4%	616	100.0%
Test Results				
Positive for Alcohol	8	0.7%	0	0.0%
Positive for Drugs	3	0.2%	0	0.0%
Negative	3	0.2%	0	0.0%
Pending	73	6.0%	0	0.0%
Unknown results and others	16	1.3%	0	0.0%
Missing	1,120	91.6%	616	100.0%

[2] Some decedents tested positive for both alcohol and drugs; counts to not sum to 1,222

Table 8 summarizes the information on drug impairment captured on the CRASH report for the 1,838 persons treated at trauma hospitals in Kentucky following a traffic crash that occurred in Kentucky. Drugs were mentioned as a contributing crash factor for 3.5% of motor vehicle drivers on the CRASH file (compared to 4.4% of fatally injured drivers in Table 4). Drug tests were reportedly administered for 8.7% of drivers (compared with 12.4% of fatally injured drivers in Table 4). Only **0.2% of drivers had a positive drug test result mentioned on the CRASH file** (compared with 1.6% of fatally injured drivers in

Table 4). Test results were listed as “Pending” for 70% of the 106 motor vehicle drivers who were reportedly tested (compared with 53% of fatally injured drivers from Table 4).

Kentucky Trauma Registry

Tables 9 and 10 summarize the reporting of drug tests, findings, and administered medications for drivers and nondrivers, respectively, by facility. We see that 72% of the driver tests were reported by just 2 hospitals, the level one facilities at the University of Kentucky and the University of Louisville. Eighty-seven percent of the driver tests were done at just 5 facilities, including the two level one facilities plus Pikeville Medical Center, Owensboro Medical Center, and Hazard ARH. The percentages of drivers tested at each facility varied considerably, as did the percentage of drivers having at least one positive drug finding. The latter ranged from a low of 35% at U of L to 96% at UK. The reasons for this wide variation are not understood at this time. It is possible that a much higher proportion of patients treated at a UK trauma hospital received medications (e.g. opioids for pain) from emergency medical services at the crash scene, or from a referring hospital, which would result in a positive drug finding.

Moreover, UK reported data on administered medications whereas U of L did not. As a result of these data limitations, as well as those mentioned in the Methods, we focused our drugged driving analysis for this sample on 1) drugs that are not commonly administered for treatment of trauma patients, and 2) a case study of UK trauma hospital that takes into account medications that were known to have been administered to the patient for medical purposes.

Table 9. Drug test information captured on trauma registry records N=1,222 motor vehicle drivers treated at a Kentucky trauma hospital following involvement in a traffic crash in Kentucky

Facility Name	Total Driver Records	Drivers Tested (% of total driver records)	Drivers Confirmed Positive (% of drivers tested)	Medications Reported
University of Kentucky Medical Center	444	203 (45.8)	195 (96.1)	415
University of Louisville Hospital	440	249 (56.6)	87 (34.9)	0
Pikeville Medical Center	86	59 (68.6)	41 (69.5)	67
Owensboro Medical Center	62	22 (35.5)	19 (86.4)	48
Ephraim McDowell Regional Medical Center	35	6 (17.2)	*	10
James B. Haggin Memorial Hospital	31	0 (0)	0 (0)	31
Hazard ARH	26	10 (38.5)	8 (80.0)	15
Frankfort Regional Medical Center	14	*	0 (0)	10
Taylor Regional Medical Center	12	6 (50.0)	5 (83.3)	0
Marcum Wallace Memorial Hospital	12	0 (0)	0 (0)	0
Rockcastle Regional Hospital	8	0 (0)	0 (0)	8
St. Claire Medical Center	8	0 (0)	0 (0)	*
Fort Logan Hospital	7	*	*	*
Harrison Memorial Hospital	7	*	*	*
Methodist Hospital Union County	7	0 (0)	0 (0)	7
Russell County Hospital	7	0 (0)	0 (0)	7
Livingston Hospital	6	0 (0)	0 (0)	6
Trigg County Hospital	*	0 (0)	0 (0)	*
Middlesboro ARH Hospital	*	0 (0)	0 (0)	*
Kosair Children's Hospital	*	*	0 (0)	0
Morgan County ARH Hospital	*	0 (0)	0 (0)	*
Parkway Regional Hospital	*	0 (0)	0 (0)	*
University of Kentucky - Children	*	0 (0)	0 (0)	0
St. Joseph Hospital (Mt. Sterling)	0	0 (0)	0 (0)	0
Total	1,222	562 (46.0)	360 (64.1)	637

* At least 1 but fewer than 5

Table 10. Drug test information captured on trauma registry records N=616 nondrivers treated at a Kentucky trauma hospital following involvement in a traffic crash in Kentucky

Facility Name	Total Nondrivers Records	Nondrivers Tested (% of total driver records)	Nondrivers Confirmed Positive (% of drivers tested)	Medication Given
University of Kentucky Medical Center	207	99 (47.9)	94 (94.9)	188
University of Louisville Hospital	197	110 (55.8)	25 (22.7)	0
Kosair Children's Hospital	60	12 (20.0)	*	*
University of Kentucky - Children	37	*	*	21
Pikeville Medical Center	26	14 (53.8)	7 (50.0)	19
Owensboro Medical Center	17	*	*	7
James B. Haggin Memorial Hospital	14	0 (0)	0 (0)	14
Hazard ARH	11	*	*	8
Ephraim McDowell Regional Medical Center	10	*	*	0
Frankfort Regional Medical Center	10	*	0 (0)	6
Marcum Wallace Memorial Hospital	8	0 (0)	0 (0)	0
Taylor Regional Medical Center	*	*	0 (0)	0
Russell County Hospital	*	0 (0)	0 (0)	*
Rockcastle Regional Hospital	*	0 (0)	0 (0)	*
Fort Logan Hospital	*	0 (0)	0 (0)	*
Livingston Hospital	*	0 (0)	0 (0)	*
Middlesboro ARH Hospital	*	0 (0)	0 (0)	*
St. Joseph Hospital (Mt. Sterling)	*	0 (0)	0 (0)	*
St. Claire Medical Center	*	0 (0)	0 (0)	*
Methodist Hospital Union County	*	0 (0)	0 (0)	*
Trigg County Hospital	*	0 (0)	0 (0)	*
Harrison Memorial Hospital	0	0 (0)	0 (0)	0
Morgan County ARH Hospital	0	0 (0)	0 (0)	0
Parkway Regional Hospital	0	0 (0)	0 (0)	0
Total	616	245 (39.8)	134 (54.7)	280

* At least 1 but fewer than 5

Analysis of Trauma Hospital Toxicology Results for Drugs not Administered for Trauma Care – All Facilities

Table 11 summarizes toxicology findings for drivers and nondrivers for whom drug tests were run at a trauma hospital. This analysis was limited to positive findings for drugs that are not commonly used in the treatment of trauma patients, including: marijuana, cocaine, methamphetamine, amphetamine, barbiturates, and methadone. A positive finding for one of these drugs can reasonably be assumed to indicate the presence of the drug at the time of the crash. **We found that 10% of all drivers (and 9% of nondrivers) in our sample had a positive finding for at least one of these drugs.** Marijuana was the most commonly detected of these drugs, being positive in 6% of drivers and 5% of nondrivers. Stimulants (cocaine, methamphetamine, amphetamine) were detected in 5% of drivers and 4% of nondrivers.

Table 11. Toxicology findings for drivers and nondrivers tested for drugs at a trauma hospital, for drugs not commonly administered for treatment of trauma patients – All facilities, N=1838

	Drivers			Non-Drivers		
Drug Type	Positive Toxicology Finding (N)	Percent Positive[1]	Percent Positive[2]	Positive Toxicology Finding (N)	Percent Positive[3]	Percent Positive[4]
Marijuana	72	12.8	5.9	30	12.2	4.9
Cocaine	16	2.8	1.3	14	5.7	2.3
Methamphetamine	21	3.7	1.7	4	1.6	0.6
Amphetamine	28	5.0	2.3	9	3.7	1.5
Barbiturate	9	1.6	0.7	2	0.8	0.3
Methadone	9	1.6	0.7	1	0.4	0.2
Any of the above	125	22.2	10.2	54	22.0	8.8

[1] Among drivers in the sample who were tested for drugs at a trauma facility (N=562)

[2] Among all drivers in the sample (N=1,222) – regardless of whether they were tested for drugs at a trauma facility

[3] Among non-drivers in the sample who were tested for drugs at a trauma facility (N=245)

[4] Among all non-drivers in the sample (N=616) – regardless of whether they were tested for drugs at a trauma facility

Case Study: University of Kentucky Trauma Center

Because UK reported data on administered medications, whereas U of L did not, we limited to UK Trauma Center our analysis of toxicology results for drugs that are commonly administered to the patient for medical purposes.

Table 12 repeats the analysis presented in Table 11 for all trauma facilities, but is limited to patients treated at UK Hospital. **We found that 17% of all drivers (and 18% of nondrivers) treated at UK Trauma Center had a positive finding for at least one of these drugs.** Marijuana was again the most commonly detected of these drugs, being positive in 12% of drivers at UK and 13% of nondrivers. Stimulants (cocaine, methamphetamine, amphetamine) were detected in 9% of drivers and 7% of nondrivers.

It is unclear why the percentage of drivers and nondrivers with positive drug toxicology findings was higher at UK than for all facilities combined.

Table 12. Toxicology findings for drivers and nondrivers tested for drugs at a trauma hospital, for drugs not commonly administered for treatment of trauma patients –UK Trauma Center, N=651

	Drivers			Non-Drivers		
Drug Type	Positive Toxicology Finding (N)	Percent Positive[1]	Percent Positive[2]	Positive Toxicology Finding (N)	Percent Positive[3]	Percent Positive[4]
Marijuana	54	26.6	12.2	27	27.3	13.0
Cocaine	10	4.9	2.3	6	6.1	2.9
Methamphetamine	16	7.9	3.6	4	4.0	1.9
Amphetamine	12	5.9	2.7	5	5.1	2.4
Barbiturate	1	0.5	0.2	0	0.0	0.0
Methadone	6	3.0	1.4	1	1.0	0.5
Any of the above	76	37.4	17.3	38	38.3	18.4

[1] Among drivers in the sample who were tested for drugs at the UK Trauma Center (N=203)
[2] Among all drivers in the sample who were treated at UK Trauma Center (N=444) – regardless of whether they were tested for drugs at UK Trauma Center
[3] Among non-drivers in the sample who were tested for drugs at UK Trauma Center (N=99)
[4] Among all non-drivers in the sample who were treated at UK Trauma Center (N=207) – regardless of whether they were tested for drugs at UK Trauma Center

Tables 13 and 14 present toxicology findings for drivers and nondrivers (respectively) who were tested for drugs at UK hospital. These tables examine toxicology findings for opioids and benzodiazepines, which are drugs that are commonly administered to trauma patients for medical treatment. UK Hospital reported that opiates (other than Oxycodone, which was reported separately) were detected in 70% of drivers, and 58% of nondrivers, who were administered a drug test. However, most of those patients were also known to receive an opioid medication in the course of their treatment, either at the crash scene, at a referring facility, or at UK Hospital in the ED or elsewhere. The timing of opioids administered at UK, relative to the time at which the drug test sample was drawn, was not reported. **Only 7 out of the 141 drivers (5%) who tested positive for opiates at UK hospital were NOT reported to have received**

an opioid medication in the course of their treatment. Thus, it is impossible with the given information to determine what proportion of the 203 tested drivers had opioids present at the time of the crash. Findings were similar for nondrivers (Table 14).

Benzodiazepines were reported less frequently, by UK Trauma Center, than opioids as administered medications. **Forty-eight out of the 203 drivers tested at UK Trauma Center (23.6%) had a positive toxicology finding for benzodiazepines, with no mention that a benzodiazepine was administered as a medication.** We have no information on the completeness of medication information on trauma registry records. Findings were similar for nondrivers (Table 14).

Table 13. Toxicology findings for drivers tested for drugs at a trauma hospital, for drugs commonly administered for treatment of trauma patients –UK Trauma Center, N=203

		Administered as Medication[1]			
Drug Type	Positive Toxicology Finding N (%[2])	At Scene of Accident	At a Referring Facility	At UK Hospital (ED or ICU)	Positive Toxicology with no Evidence of Medication Administered
Opiates	141 (69.5%)	22	27	127	7
Oxycodone	23 (11.3%)	-	-	-	-
Benzodiazepine	75 (36.9%)	6	5	26	48

[1] In any setting (at scene of accident, at a referring facility, in the trauma hospital ED, or in the trauma hospital ICU)

[2] Percent of drivers in sample who received a drug test at UK Hospital (N=203).

Table 14. Toxicology findings for nondrivers tested for drugs at a trauma hospital, for drugs commonly administered for treatment of trauma patients –UK Trauma Center, N=99

		Administered as Medication[1]			
Drug Type	Positive Toxicology Finding N (%[2])	At Scene of Accident	At a Referring Facility	At UK Hospital (ED or ICU)	Positive Toxicology with no Evidence of Medication Administered
Opiates	57 (57.6%)	7	10	52	5
Oxycodone	6 (6.1%)	-	-	-	-
Benzodiazepine	27 (27.3%)	*	0	7	20

[1] In any setting (at scene of accident, at a referring facility, in the trauma hospital ED, or in the trauma hospital ICU)

[2] Percent of passengers in sample who received a drug test at UK Hospital (N=99).

* At least 1 but fewer than 5

Hospital Billing Data

We linked the 1,838 patients treated at Kentucky trauma hospitals with hospital billing records, to assess the use of ICD-9-CM code 305, "nondependent abuse of drugs," for the purpose of identifying drugged driving in hospital billing records. We were able to link 1,530 (83%) of the 1,838 to a hospital inpatient and/or outpatient billing record. Of those, 1,028 were drivers.

Table 15 summarizes findings on the question of how often an ICD-9-CM code for "nondependent abuse of drugs," on the hospital billing record for drivers, is supported by a positive toxicology finding for the same substance on the matching trauma registry record. Although the sample size is quite small, for the sedative/hypnotic/anxiolytic, opioid, cocaine, and amphetamine/stimulant categories, an ICD-9-CM code for "nondependent abuse" was supported by a positive toxicology finding for the same type of drug in 10 out of 11 cases (91%). Additionally, an ICD-9-CM code for "nondependent abuse of cannabis" was supported by a positive toxicological finding for marijuana in 11 out of 15 cases (73%). **Overall, there was a supporting positive toxicology finding on the trauma registry record in 21 out of 26 (81%) of cases where an ICD-9-CM code of "nondependent abuse" of drugs was present on the hospital billing record.**

This finding suggests that the ICD-9-CM code 305 may be a fairly reliable proxy for presence of drugs in motor vehicle drivers in hospital billing records (both inpatient and emergency department).

Table 15. Percent of drivers with ICD-9-CM code for drug dependence on the hospital billing record, who had a positive toxicology finding for that drug in the trauma registry (N=1,028 drivers with linked trauma registry-hospital billing records)

	ICD-9-CM Codes for Nondependent Abuse	Number of Drivers Having this ICD-9-CM Code on the Billing Record	Trauma Registry Toxicology Category	Number of Drivers with ICD-9-CM Code who had Positive Toxicology Finding for this Drug in the Trauma Registry Record
Cannabis	305.20 – 305.22	15	MARI	11
Sedative, hypnotic or anxiolytic	305.40 – 305.42	*	BARB or BENZ	*
Opioid	305.50 – 305.52	*	OPI or OXY or METHD	*
Cocaine	305.60 – 305.62	*	COC	*
Amphetamine or related acting sympathomimetic abuse	305.70 – 305.72	*	AMPH or METH	*

* At least 1 but fewer than 5

However, the results presented in Table 16 suggest that **the 305 code will have low sensitivity for drugged driving**, i.e. it will fail to be documented on the hospital billing records for most drivers with drugs present. We identified 63 drivers with a positive finding for marijuana in the trauma registry file; of those, 11 (17.5%) had an ICD-9-CM code for nondependent abuse of cannabis. Combined results for cocaine, methamphetamine, amphetamine, barbiturates and methadone indicate that for only 4 out of 63 (6.3%) positive trauma registry toxicology findings for those drugs was there a corresponding ICD-9-CM code for nondependent abuse on the hospital billing record. Even considering nonspecific ICD-9-CM codes for nondependent abuse of unspecified drugs does not account for this difference.

Thus, while use of the ICD-9-CM code 305 for nondependent abuse of drugs in hospital billing data sets will capture additional cases of drugged driving not detectable using CRASH data, most true cases of drugged driving will go undetected by that code.

Table 16. Percentage of hospital billing records mentioning acute drug poisoning or drug dependence, for drivers with positive toxicology findings in the trauma registry (by drug type detected in toxicology) (N=1,028 drivers with linked trauma registry-hospital billing records)

		Acute Poisoning		Adverse Effects in Therapeutic Use	Nondependent Abuse	
Drug Type	Drivers with Positive Toxicology Finding in Trauma Registry	Specific Drug (N)	Unspecified Drug (N)		Specific Drug (N)	Unspecified Drug (N)
Marijuana	63	--	*	0	11	*
Cocaine	11	*	0	0	*	*
Methamphetamine	17	*	0	--	*	*
Amphetamine	22	*	0	0	*	*
Barbiturate	6	0	0	0	0	0
Methadone	7	0	0	--	0	*
Any of the Above	102	--	*	0	--	9

* At least 1 but fewer than 5

CONCLUSION AND RECOMMENDATIONS

Opportunities to increase capture of drugged driving information on fatalities:

1. Only 4.7% of motor vehicle decedents in this study had any mention of positive drug findings listed on the death certificate, despite the fact that based on FARS data, 38% of drivers in the sample had at least one positive drug toxicology finding. Coroner/Medical Examiner training and education has potential to increase the capture of drug toxicology results on death certificates, as deaths are certified through the Kentucky Electronic Death Reporting System (KY-EDRS). KRS 72.026 mandates post-mortem toxicology testing for suspected drug overdoses. We recommend that KSR 72.026 be amended to require testing of drivers in which there is evidence of possible drug involvement.

2. FARS only lists the drug types that tested positive, not the concentration levels of those drugs. It is worth exploring whether the Kentucky FARS program has access to drug concentration levels on toxicology reports. If so, a routine report of drug concentration levels in drivers, say to the Governor's Executive Committee on Highway Safety, might be valuable for monitoring emerging drugged driving issues.

Opportunities to increase capture of drugged driving information for patients treated at hospitals and emergency departments in Kentucky:

1. Implement routine reporting of toxicology results from trauma registry file, at least for drugs not used for treatment of trauma. Explore adding information to trauma registry file such as 1) concentrations of detected drugs; and 2) some indication of whether drug test sample was taken in ED before or after medications were administered at the trauma hospital.

2. Implement routine reporting of the ICD-9-CM code 305 ("nondependent abuse of drugs") on hospital billing records for patients involved in traffic crashes. Findings of this report, although limited by a small sample size, indicate that, when this code is present on the hospital billing record, there is usually a corresponding drug positive toxicology finding on the trauma registry record. However, our findings also suggest that this code is present on the hospital billing record in only a small percentage of all true cases of driver drug impairment.
3. Investigate variations in toxicological testing panels used by trauma hospitals, and whether there would be a benefit to standardization.

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