Relationship Between Clandestine Methamphetamine Laboratory Seizures and Burns in Kentucky

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Methamphetamine is a highly addictive stimulant that is synthetically produced using equipment and chemicals available in the community. Its burden to society may be determined through a number of mechanisms, including the imposed strain on healthcare systems. The evolution of methamphetamine use and production methods has led to reports of increased methamphetamine related burn admissions among hospital burn units[1-3] . Current literature identifies an increase in injury severity, comorbid complications, and cost of care associated with methamphetamine related burn injuries[1-5]. The intent of this study is to identify burn injuries in Kentucky and assess whether a statistically significant association exists between burns and the number of methamphetamine laboratory seizures in Kentucky counties.

Background

Similar to other stimulants, effects of methamphetamine result from increased activity of the central nervous system. Methamphetamine also produces and array of psychological effects, including euphoria, increased alertness, increased libido, irritation, aggressiveness, and paranoia. It can be injected, smoked, inhaled, or ingested orally. Injection and smoking result in the user experiencing a "rush" effect, coupled with a longer duration of action than other abused stimulants. The combination of methamphetamine's stimulant and psychological effects, near immediate onset, and extensive duration of action present a high potential for abuse and addiction. Addiction and long-term use of methamphetamine result in structural and functional alterations in the brain, thought to be responsible for emotional and cognitive changes including depression, psychosis, and memory loss. Dental problems, commonly referred to as "meth mouth”, and damage to the cardiovascular system are also associated with long-term methamphetamine use[6].

Methamphetamine Abuse in the United States

First synthesized in 1919 from ephedrine, methamphetamine is a phenethylamine molecule that is chemically related to other stimulants, including cocaine, amphetamine, and pseudoephedrine. It was first introduced by the pharmaceutical industry for use as an inhaled aerosol indicated to treat asthma and nasal congestion[7]. Effects on the central nervous system were noted, however, and incited its marketing and use for an array of indications, including narcolepsy (excessive tiredness) and fatigue.

The continued use of methamphetamine led to a variety of tampering methods to overcome increased tolerance to stimulant effects, including combination with opioids and intravenous injection of inhaler and tablet contents. Despite gradual recognition of abuse potential and adverse effects of amphetamine stimulants throughout the mid-20th century, licit production of oral amphetamines reached 10 billion doses in 1970[7]. Due to extensive reports of abuse and diversion, methamphetamine was regulated by the Drug Enforcement Administration under Schedule II of the Controlled Substance Act in 1971, and all injectable forms of the drug were removed from the market[8].

As a consequence of regulation and decreased pharmaceutical supply, methamphetamine production shifted heavily to illicit manufacturing in clandestine laboratories[7]. Biker gangs were responsible for approximately 90% of methamphetamine production in the United States during the 1970s through 1980s, with the majority of use concentrated on the West coast[7]. During the

1990s, production and use spread through the Midwest, and then to the Northeast within the last decade[7].

Current Methamphetamine Supply and Production Methods

In 2010, 11,239 methamphetamine clandestine laboratory incidents were reported in the United States, including lab seizures, manufacturing site discoveries, and identification of production supplies and equipment[7]. Currently, regional disparities in sources of methamphetamine supply are observed. The Western United States receives a majority of the total methamphetamine supply from Mexican producers, extending to the Midwest where urban areas receive a large percentage of methamphetamine through established cocaine and marijuana distribution networks[8,9]. In sparsely populated rural and smaller metropolitan areas, methamphetamine production in clandestine laboratories is becoming more prevalent. As a whole, clandestine laboratory production is estimated to provide up to 35 percent of the total domestic supply[9,10].

Methamphetamine is produced using various methods, equipment, and chemical precursors. Two primary precursors have been used to produce methamphetamine. The first illicit producers began using the compound commonly known as “P2P” until the DEA imposed its regulation as a Schedule II controlled substance in 1980, and initiated monitoring of its chemical manufacture in 1987. After these regulations on methamphetamine’s most important ingredient, manufacturers discovered that ephedrine and pseudoephedrine, found in decongestant products stocked by pharmacies, could be used as a precursor, marking the advent of today’s common manufacture methods[7].

Two primary methods of production were subsequently developed. The “red phosphorous” method involves, first, isolating the ephedrine or pseudoephedrine from commercially available tablets with water or alcohol and a heat source[7]. Red phosphorous and iodine are then added to chemically convert the ephedrine or pseudoephedrine to methamphetamine, which is then extracted using various solvents[7]. The “Birch” method involves combining a metal, often lithium extracted from batteries, with the pseudoephedrine product, and then adding anhydrous ammonia, an agricultural fertilizer, to yield methamphetamine[11].

Most recently, the “one-pot” or “shake-and-bake” method has become more prevalent[9,12]. In this process, pseudoephedrine is crushed and mixed with ammonium nitrite in a container, often a two-liter soda bottle[7,11]. “Shake-and-bake” production requires less supplies and pseudoephedrine, no source of heat, and is much less complex than other established methods. Two-liter sodas bottles used in this method are often found discarded along the roadside in rural areas[7,11]. The DEA reports that 80% of all methamphetamine lab seizures in 2010 were found to be using the ‘shake-and-bake” method[12].

Nearly every chemical used in each production method is caustic and/or flammable, presenting the potential for injury due to direct exposure from handling chemicals and waste products, or resulting from explosion during manufacture. Therefore, the production of methamphetamine presents secondary consequences to individuals not directly involved in its manufacture[5,13-15). Other residents at the laboratory site may be exposed to harmful ingredients and gaseous fumes released from the production process, in addition to the risk of injury from being in proximity to a production-related explosion. Members of the surrounding community may be exposed to discarded waste products, particularly from the “shake-and-bake” method.

Law-enforcement officials and hazardous waste management teams are at risk of exposure and injury during investigation and cleanup. In addition to risk of injury, the cost of cleanup per lab incident is estimated between $2,000 and $10,000[13].

Methamphetamine in Kentucky

There were 1,070 methamphetamine clandestine laboratory incidents reported in Kentucky in 2010, a substantial increase from 428 incidents in 2008[16]. As a percentage of all drug-related arrests, methamphetamine comprised 11% in 2010, up from 6% in 2008[16]. Methamphetamine has become less expensive for users, and arrests in Kentucky have surpassed cocaine, for which prices have increased[16].

In addition to the gross amount and percentage of total drug arrests growing, crime related to methamphetamine is growing at a faster rate than overall methamphetamine incidents[16]. This is likely attributed to increased incidence of theft of ingredients needed for "shake-and-bake" methamphetamine, including pseudoephedrine, anhydrous ammonia, and ammonium nitrite[16]. The Kentucky State Police have reported this to be the most commonly used production method[16].

In 2005, KRS 218A.1446, also known as the 'Pharmacy Log Law', was passed, requiring pharmacies to track and report each transaction involving an over-the-counter pharmaceutical product containing pseudoephedrine, as part of the Combat Methamphetamine Act of 2005[8]. The law required individuals to present government-issued identification in order to purchase products containing pseudoephedrine, and limited individuals to 3.6 grams of pseudoephedrine per day and 9 grams of pseudoephedrine per 30 days (an adequate supply for consumption of the maximum recommended daily dose for each of 30 days). Consequently, the number of methamphetamine labs in Kentucky decreased drastically in 2006 and 2007, only to sharply increase in each subsequent year up to 2010, despite a 2008 mandate for pharmacies to electronically track transactions[15]. The primary method of circumvention is known as "smurfing", a practice where multiple buyers purchase the legal limit of pseudoephedrine in a given time period, and combine purchases to accumulate the 20 to 30 grams of pseudoephedrine (equating to approximately 250 to 100 tablets) required to produce a typical "batch" of methamphetamine[17,20]. Since July, 2012, individuals in Kentucky Have been limited to 7.2 grams of pseudoephedrine per 30 days, and 24 grams per year[18].

Kentucky laboratory incidents in 2009 were widespread geographically, with a higher frequency of reports occurring in areas of the state located between Interstate 65 and Interstate 75[16]. Specifically, patterns of concentration within the Louisville, Bowling Green, and Owensboro areas, as well as Laurel and Pulaski Counties were noted. Contrary to perceptions possibly attributed to opioid abuse, incidents in eastern Kentucky were sparse[16].

Methamphetamine Related Burn Injuries

Clandestine methamphetamine production settings, including makeshift laboratories and mobile "shake-and-bake" units pose a dangerous scenario for manufacturers, bystanders, law enforcement, and the surrounding community. All methods of production present tremendous risk of injury from a number of mechanisms, including chemical and thermal burns.

The risk of injury due to chemical exposure is high, as the majority of ingredients used in the manufacture of methamphetamine are hazardous. Injuries to the eyes, skin, and respiratory tract resulting from contact with vapors produced by routine reactions and accidents involving explosion have been reported. Exposure to anhydrous ammonia, a caustic liquid conventionally used as an agricultural fertilizer and a component of the 'Birch' production method, commonly results in injury. A retrospective review of 49 burn patients treated for chemical burns and/or ammonia exposure found that patients with ammonia exposure related to methamphetamine production had significantly worsened outcomes, including longer hospital length of stay, greater skin grafting requirements, longer duration of mechanical ventilation, and higher rates of subsequent complications versus cases unrelated to methamphetamine[19].

Thermal burn injuries incurred from explosions during the manufacture of methamphetamine have been studied among burn units in the United States. Analysis of methamphetamine related burn cases reflect the complicated and costly nature of caring for this patient population, in contrast to non-methamphetamine control patient groups.

Methamphetamine related burn patients are reported to present with more severe injuries[1-5,13,19]. A retrospective review of burn patients over a seven year period at a single-center burn unit found that patients with thermal burn injuries resulting from methamphetamine production had a higher incidence of third degree burn and larger percentage of total body surface area (TBSA) burned upon presentation versus non-methamphetamine related burn patients[5].

In addition to increased injury severity upon presentation, methamphetamine related burn patients have more complicated hospital courses. A single center case-control study of methamphetamine-related burn patients matched to control patients by age and percentage of TBSA burned found that methamphetamine burn patients had higher pain control and sedative requirements, agitation scores, and restraint use[2]. Additionally, statistically significant increases in inhalational injury, ventilator days, and tracheostomy procedures were noted versus control patients. Analysts found an increase in hospital length of stay and mortality in the methamphetamine burn group, but the difference was not statistically significant[2]. In a separate single center study, an over four-fold increase in incidence of hospital acquired pneumonia, respiratory failure, and sepsis was present, as well as a three-fold increase in mortality versus non-methamphetamine related burn patients over a six year span[5].

As a result of presenting with a more severe injury and developing a complicated hospital course, the cost of treating a methamphetamine related burn patient is substantially higher than that of a non-methamphetamine related burn. A retrospective case-control study of all burn patients in a regional burn center over a span of four years found that those with methamphetamine-positive toxicology results had 1.5 times higher hospital charges per day, in addition to longer average hospital length of stay[1]. Methamphetamine-positive patients were largely uninsured, as 66.7% lacked third party coverage, versus 17.7% of control burn patients. Other studies have reported even higher rates of uninsured within the methamphetamine related burn population[2,13]. Increased cost of care is widely reported, with average total charges per visit ranging from approximately 1.5 to 3 fold higher in methamphetamine burn patients versus controls[1-3,5,13]. One single-center study reported total inpatient visit charges for 56 burn patients with methamphetamine-positive drug tests in 2004 to be $7.09 million, a mean of $126,608 per patient, versus $67,415 per patient for burn patients with negative drug tests[1]. The highest total inpatient visit charge for one methamphetamine-positive burn patient in this study was $954,673[1].

The impact of methamphetamine related burn injuries is multifactorial. Patients with more severe injuries, complicated hospital courses, increased length of stay, and higher rates of uncompensated care have placed an incredible burden on regional burn centers charged with providing treatment for this patient population. It is estimated that the rising prevalence of the "shake-and-bake" method is responsible for the increase in number and severity of methamphetamine related burn cases. With the number of methamphetamine laboratory incidents rising rapidly in the state of Kentucky, copious resources are devoted to abuse prevention, law enforcement initiatives, and healthcare compensation for related burn injuries.

As laboratory incidents are reported in geographically concentrated areas of the state, the hypothesis of this study is that a statistically significant association exists between number of burns and the number of methamphetamine laboratory seizures in Kentucky counties.

Methods

The purpose of this study is to determine whether Kentucky counties with more methamphetamine laboratory seizures are associated with a greater number of burns treated at Kentucky hospitals. All study data were obtained from 2010, as complete burn and laboratory seizure data were available for this year.

Data on the number of methamphetamine laboratory seizures in Kentucky counties were obtained from the Kentucky State Police 2010 Crime in Kentucky report. KRS 218A.1432 defines a "meth lab" as having two or more chemicals, or two or more pieces of equipment used to manufacture methamphetamine, and lab seizures reported by the Kentucky State Police are therefore based upon this definition.

Burn data were obtained from the Kentucky Cabinet for Health and Family Services Office of Health Policy Public Use Data Set. Hospitals in Kentucky are required to report specified data from each hospitalization, per 900 KAR 7:030 Section 3. This database was queried for all entries with a primary diagnosis code indicating a chemical or thermal burn injury, as defined in ICD-9 format by values 940 through 949.5. All data contain de-identified patient sociodemographic information, including age, race, sex, and location including county and zip code of reported residence. Details of each hospital encounter include treatment facility identification, diagnosis and procedure codes, payer source, length of stay, and total charges incurred. Given the data sources for this research, the University of Kentucky Institutional Review Board ruled that this project does not qualify as research involving human subjects.

Descriptive statistics were summarized using Microsoft Excel. A multivariate regression model was created to analyze the statistical association between laboratory incidents and burns, while controlling for the concurrent effect of county population and high school graduation rates. Burn incidents resulting from an occupational injury, as determined by billing as a 'Worker's Compensation' claim, were omitted from the regression analysis.

Results

Burn Patient Characteristics

The query for burn cases returned 403 results, with 346 cases representing Kentucky residents. Only cases representing Kentucky residents were included in the descriptive results and further statistical analyses. Table 1 presents the demographics of Kentucky burn patients in 2010. Patients were primarily white (91%) and male (67.3%). A fairly even distribution was noted for patients of each age group.

Table 1. Burn Patient Demographics

Age* (years)	Frequency	Percentage
0 – 15	78	22.5%
16 – 30	49	14.2%
31 – 45	68	19.7%
46 – 60	72	20.8%
>60	79	22.8%
Sex		
Male	233	67.3%
Female	113	32.7%
Race		
White	315	91.0%
Black	28	8.1%
Other	3	0.9%

*Kentucky Cabinet for Health and Family Services Office of Health Policy Public Use Data Set reported age in 5 year increments

Emergency department admissions accounted for 61.3% of all admissions, while trauma center admissions (representative of patients who present to accredited trauma departments with acutely life-threatening injuries) accounted for 14.7% of the total. All cases had a primary ICD-9 diagnosis of thermal or chemical burn injury.

University of Louisville Hospital accounted for 26% of all admissions, the highest of all Kentucky hospitals in 2010. Combined, University of Louisville Hospital and University of Kentucky Chandler Hospital, the state's two adult Level 1 trauma centers, and Kosair Children's Hospital, the state's only specialized pediatric trauma center and burn unit, accounted for 64.2% of all admissions.

Payer information was reported for each burn case in the form of primary, secondary, and tertiary payer information. As indicated in Figure 1, primary pay sources were predominantly non-commercial, with Medicaid, including Medicaid Managed Care Organizations (MCOs), comprising the largest percentage of primary payers. Commercial and self pay sources represented only 26% of all primary payers. Uncompensated care accounted for 12.4% of primary pay sources, and were associated with injury incidents responsible for $2,690,152 in total charges. A secondary and/or tertiary pay source was present in 20.2% of injury incidents.

Figure 1. Percentage of Burn Cases per Primary Pay Source

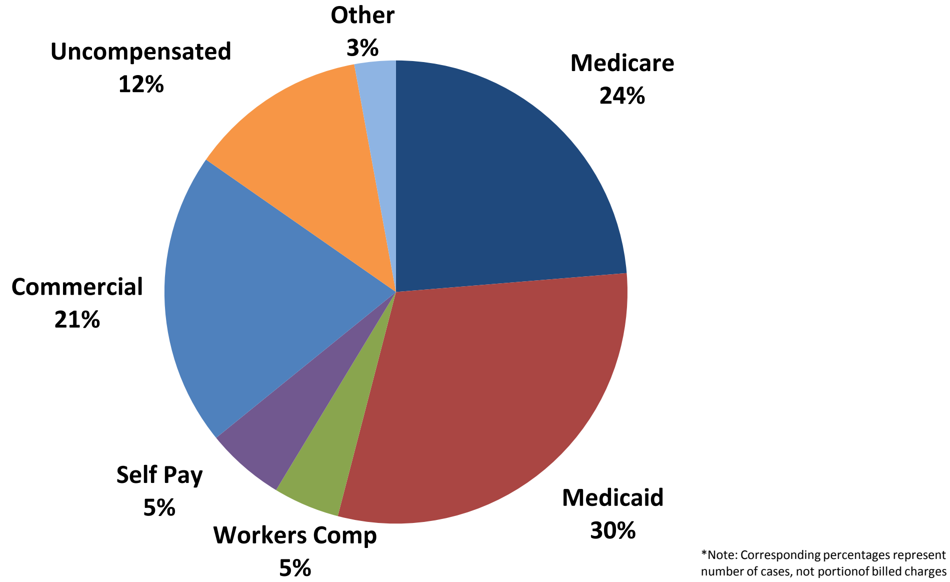
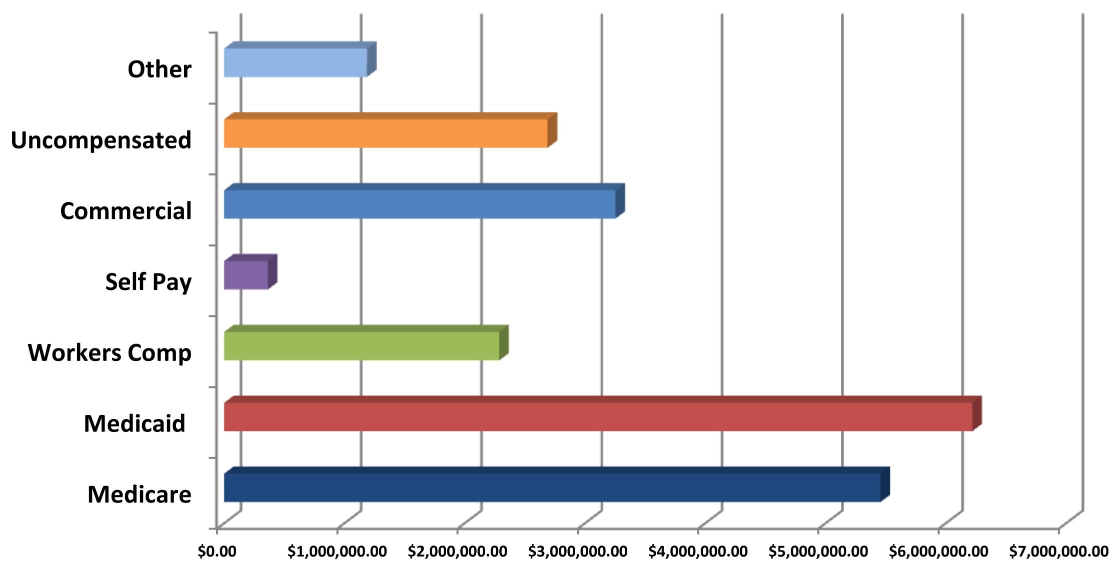


Figure 2. Billed Charges per Primary Pay Source



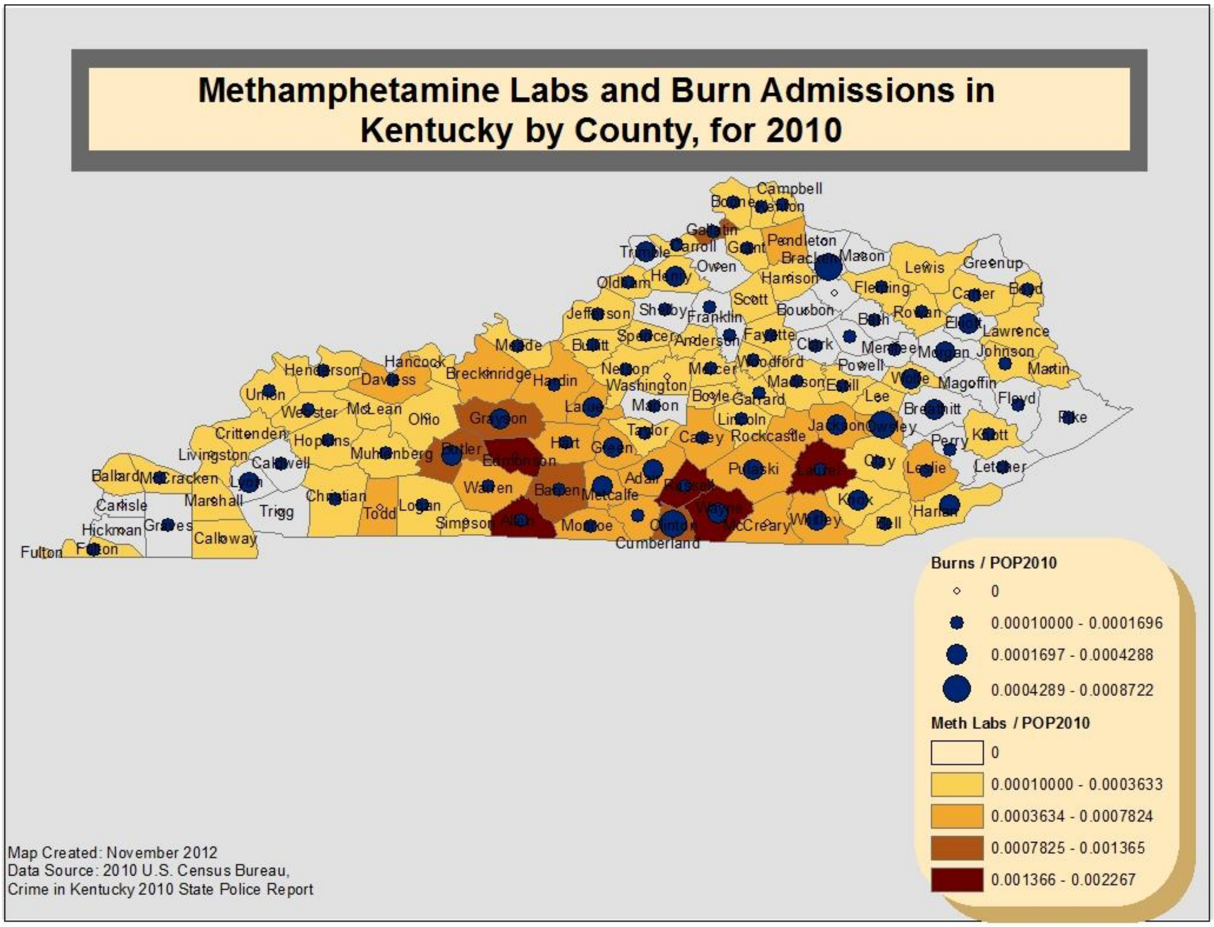
The mean length of stay was 8 days, with a maximum of 155 days. The mean total charge for all burn cases was $62,032 (SD $156,651), with a range of per-case charges from $1,569 to a maximum of $1,569,251. A total of $21,463,225 in charges were billed for the burn patient group in 2010. Time of discharge was evenly distributed throughout all four quarters of the 2010 calendar year. Discharge status coding revealed an inpatient mortality rate of 4% within the patient group.

Methamphetamine Laboratory Seizures per Kentucky County

A geographical representation of 2010 burn admissions and methamphetamine laboratory seizures per Kentucky county of residence, controlling for county population, is provided in Figure 3. After controlling for population density, a concentrated pattern of labs is noted in the south central area of Kentucky. Laboratory incidents are also noted in areas extending to western and north central Kentucky. A pocket of laboratory incidents is represented along the northeastern state line.

Variable numbers of burn cases are noted throughout the state. A higher density of burn is noted in multiple counties within south central Kentucky. Additionally, a segment of eastern Kentucky counties represent a higher number of burns.

Figure 3. Methamphetamine Labs and Burns Admissions in Kentucky by County, for 2010



Statistical Analysis

The following equation represents the regression model:

$$Burns = \beta_0 + \beta_1 Labs + \beta_2 Pop10 + \beta_3 HSGrad + e$$

Labs represents the number of methamphetamine laboratory incidents for each county in 2010. The hypothesis is that the number of burns would increase as the number of labs increase. *Pop10* represents the county population in 2010. The hypothesis is that the number of burns would increase as county population increases. *HSGrad* represents the percentage of high school graduates in each included county for the year 2010. The hypothesis is that the number of burns would increase as the percentage of high school graduates per county decreases.

Table 2 represents the regression results. There were 120 observations included in the analysis, accounting for data from each Kentucky county. The increased presence of meth labs positively influenced the number of burns per county (Coef. 0.045, p-value = 0.0133). For each twenty-two additional meth lab incidents in a county, there tended to be one additional burn injury. As expected, controlling for county population demonstrated a statistically significant effect on number of burns (Coef. 0.963, p-value = <0.001). For approximately every 10,000 person increase in county population, there tended to be one additional burn injury. An increased percentage of high school graduates per county had a statistically significant negative effect on burns (Coef. -0.141, p-value = <0.001). Seven percent more high school graduates were associated with one less burn patient.

Table 2. Regression Results

R Square	0.857
Observations	120

	Coefficients	*P-value*
Intercept	9.434	<0.0001
Labs	0.045	0.0133
Pop10	0.963	<0.0001
HSGrad	-0.141	<0.0001

Conclusion

After omitting occupational injuries, as well as controlling for county population and high school graduation rates within the sample, this multivariate regression model demonstrates that the number of burn injuries show a small but statistically significant positive relationship with the number of methamphetamine lab incidents for the year 2010.

Discussion

The results and interpretation of this regression analysis provide evidence of the relationship between methamphetamine production and increased burn injuries that have been detailed in recent health literature and media reports, based upon county-level data from Kentucky. After normalizing for county population, a visual geographic pattern of varying methamphetamine lab and burn density (Figure 3) depicts the noticeable correlation between the two plotted densities, particularly spanning throughout the south-central corridor of the state. This descriptive correlation is supported by the results of the regression model, which indicates the statistically significant relationship between lab incidents and burn injuries in Kentucky.

Model Variables

Control variables were chosen to account for the effect of factors outside of methamphetamine production on burn injuries, to the greatest extent possible. Since the number of discharges were distributed evenly for all four quarters within the burn data, time of year was not controlled for within the regression model. Accounting for county population was necessary, as its effect on gross number of burn injuries resulting from each county is evident. The inclusion of high school graduation rates as a control variable served as a proxy of burns related to "lifestyle". Since there are no direct means of identifying the source of each burn injury from this deidentified data, assumptions about lifestyle within each county were attributed from this variable. Higher graduation rates were assumed to represent residents with occupations and living characteristics that altered burn risk, such as office jobs and urban or suburban living. Lower graduation rates were assumed to represent residents with a more rural lifestyle, such as farming, which could introduce a greater burn risk related to daily activities such as handling caustic chemicals, and the common practice of incinerating household wastes on one's own property.

Limitations

A general limitation to this study is the lack of access to patient-specific identifiers of methamphetamine production used in current literature, including drug test results and subjective incident information, which would conclusively identify methamphetamine related burn injuries.

The burn data are limited by the exclusion of out-of-state hospital admission data. A high concentration of methamphetamine laboratory incidents and burn admissions to Kentucky hospitals were noted in the south central area of the state. However, the nearest access to trauma care for many of these counties is in Tennessee. For example, Allen County, KY (dense with both burns and lab incidents) resides 119 miles from Louisville, making Nashville the closest location for trauma care at only 61 miles distance. A similar situation is true for counties in southeastern areas of Kentucky with closer proximity to trauma care in Knoxville. This likely leads to underrepresentation of Kentucky hospital burn admissions for methamphetamine related burns occurring in the most lab-dense areas of the state. Future studies may obtain data from surrounding states that would further strengthen this relationship.

Methamphetamine laboratory data are affected by state-issued definition of a "meth lab" and its effect on incident reporting. KRS 218.A 1432 requires two or more chemicals, or two or more pieces of equipment used in manufacturing meth to be reported as laboratory seizure[16].

However, multiple labs in close proximity are reported as single laboratory, leading to an underrepresentation of true meth lab seizures[16]. Additionally, the advent of “shake-and-bake” manufacture likely results in many production supplies, that are relatively inconspicuous in relation to traditional production equipment, going undetected or unreported.

In addition to these factors, the results are limited by the absence of other potentially relevant variables providing utility in identifying methamphetamine related burn injuries from other injury sources. Though occupational burn injuries were identified using payer information coded as “worker’s compensation”, injuries resulting from other common incidents such as house fires or recreational activities were not. Identifying home heat source utilization and smoking rates in each county would be one method of controlling for these injuries, serving as a proxy for burn injuries related to house fires.

Policy Impact and Further Study

As is detailed in the introduction of this paper, methamphetamine use is currently increasing at the state level. In addition to the established consequences of meth abuse, the evolution of “shake-and-bake” production has extended consequences to meth producers as well as uninvolved members of the community. As the costs of methamphetamine addiction have been estimated in established literature, so have the healthcare costs of methamphetamine related burn injuries. The cost of burn treatment extracted from this study’s data supports that of previous literature, and results of this statistical analysis support the assumption that many of these identified burns are related to methamphetamine production. Of the $21.5 million in billed charges resulting from these injuries, 11.7 million (54%) were billed to publicly funded Medicaid and Medicare. Uncompensated care accounted for 12% of billed charges, leaving individual hospitals responsible for $2.7 million related to care that would be unpaid. As previous studies have identified treatment costs to be up to three-fold higher in methamphetamine burn patients and rates of uninsurance to be approximately four-fold, it is estimated that methamphetamine related burn patients account for a higher per-incident and percentage of overall cost within this sample[1-3,5,13]. The great financial burden of methamphetamine burn treatment is therefore reflected in the cost data obtained from this sample.

Recent literature has demonstrated the relationship between pseudoephedrine sales and methamphetamine laboratory incidents in Kentucky[10]. Results from this study corroborate these previous findings by demonstrating a significant relationship between methamphetamine laboratories and burn injuries in the state of Kentucky. Recent regulations have strengthened the sales restrictions on pseudoephedrine, reducing the amount allowed per purchase and per month in an attempt to harness methamphetamine production within the state. Current legislative debate regards the potential of further restricting its availability by labeling pseudoephedrine as a legend drug, therefore requiring a prescription for purchase. Making pseudoephedrine available through prescription only could potentially reduce its acquisition for methamphetamine manufacture, therefore reducing its production within the state. In addition to decreased costs of addiction and healthcare burden, the financial strain on law enforcement related to staffing and lab site cleanup could be reduced, as could the burden on Kentucky prison systems. Potential concerns would be the increased incidence of diversion and pharmacy robbery due to restricted availability, and access limitations to patients who legitimately use the product.

Future studies in this area could expand upon this research model. Replication of this design should first be done with similar data from additional time periods within Kentucky in order to demonstrate consistency of effect. Expanding the investigation to include burn data from Kentucky patients treated at facilities in surrounding states would likely strengthen the validity of these findings.

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References

1. Burke BA, Lewis RW 2nd, Latenser BA, Chung JY, Willoughby C, Kealey GP, Wibbenmeyer LA. “Methamphetamine-related burns in the cornbelt” *J Burn Care Res*. 2008 Jul-Aug;29(4):574-9.

2. Santos AP, Wilson AK, Hornung CA, Polk HC Jr, Rodriguez JL, Franklin GA. “Methamphetamine laboratory explosions: a new and emerging burn injury” *J Burn Care Rehabil*. 2005 May-Jun;26(3):228-32.

3. The Associated Press. “Shake-and-bake' meth fills hospitals with burn patients” *PoliceOne.com*, Web. Jan 23, 2012

4. Mitka M. “Meth lab fires put heat on burn centers.” *JAMA*. 2005 Oct 26;294(16):2009-10.

5. Spann MD, McGwin G Jr, Kerby JD, George RL, Dunn S, Rue LW 3rd, Cross JM. “Characteristics of burn patients injured in methamphetamine laboratory explosions” *J Burn Care Res*. 2006 Jul-Aug;27(4):496-501.

6. National Institute on Drug Abuse: Research Report Series. “Methamphetamine Abuse and Addiction”. NIH Pub No. 06-4210. Revised 2006 Sep. Web.

7. Vearrier D, Greenberg M, Ney Miller S, et al. Methamphetamine: History, Pathophysiology, Adverse Health Effects, Current Trends, and Hazards Associated with the Clandestine Manufacture of Methamphetamine. *Dis Mon*. 2012 Feb;58(2):38-89.

8. Drug Enforcement Administration Office of Diversion Control: Drug & Chemical Evaluation Section. “Methamphetamine”. 2012 Jul. Web, Available at: http://www.deadiversion.usdoj.gov/drugs_concern/meth.pdf

9. U.S. Department of Justice National Drug Intelligence Center. “National Drug Threat Assessment 2011”. 2011, Aug. Web, Available at: http://www.justice.gov/archive/ndic/pubs44/44849/44849p.pdf

10. Talbert J, Blumenschein K, Burke A, et al. “Pseudoephedrine Sales and Seizures of Clandestine Methamphetamine Laboratories in Kentucky” *JAMA*. 2012 Oct; 308(15):1524-6.

11. METH Awareness and Prevention Project of South Dakota. “Types of Meth Labs”. 2000. Web, available at: www.mappsd.org/Types of Labs.htm

12. USA Today. "Meth Fills Hospitals With Burn Patients". 23 Jan, 2012. Web, available at: http://www.methproject.org/action/details/news-story-2012-01-23.html

13. Danks RR, Wibbenmeyer LA, Faucher LD, Sihler KC, Kealey GP, Chang P, Amelon M, Lewis RW 3rd. "Methamphetamine-associated burn injuries: a retrospective analysis." *J Burn Care Rehabil.* 2004 Sep-Oct;25(5):425-9.

14. Lineberry T, Bostwick JM. "Methamphetamine Abuse: A perfect Storm of Complications" *Mayo Clin Proc.* 2006;81(1):77-84

15. Sheridan J, Bennett S, Coggan C, Wheeler A, McMillan K. "Injury associated with methamphetamine use: A review of the literature" *Harm Reduction Journal.* 2006; 3:14

16. Kentucky State Police. "Methamphetamine Manufacturing in Kentucky 2010". 22 March, 2011. Web, available at: http://odcp.ky.gov/NR/rdonlyres/BCB964F4-8365-4E3D-BC3D-E30A50C19930/0/MethamphetamineManufacturinginKY2010Final.pdf

17. Office of National Drug Control Policy. "Report to Congress on Use of HIDTA Funds to Combat Methamphetamine Trafficking". July 2011. Web, available at: http://jrnetsolserver.shorensteincente.netdna-cdn.com/wp-content/uploads/2011/07/hidta_meth_2011.pdf

18. KRS 218A.1446. Web, available at: http://www.lrc.ky.gov/krs/218a00/1446.PDF

19. Bloom GR, Suhail F, Hopkins-Price P, Sood A. "Acute anhydrous ammonia injury from accidents during illicit methamphetamine production" *Burns*; 3 4 (2008) 713 –718

20. Burke BA, Lewis RW, Latenser BA, Chung JY, Willoughby C. "Pseudoephedrine legislation decreases methamphetamine laboratory-related burns" *J Burn Care Res*. 2008 Jan-Feb;29(1):138-40

21. http://www.kiprc.uky.edu/projects/trauma/reports/TraumaRegistryReport2010final.pdf

22. Socie E, Duffy RE, Erskine T. "Substance Use and Type and Severity of Injury Among Hospitalized Trauma Cases: Ohio, 2004–2007" *J Stud Alcohol Drugs* 2012 Mar;73(2):260-7. Web. 7 July 2012.

23. Warner P, Connolly JP, Gibran NS, Heimbach DM, Engrav LH. "The methamphetamine burn patient." *J Burn Care Rehabil.* 2003 Sep-Oct;24(5):275-8.

24. Tominaga GT, Garcia G, Dzierba A, Wong J. "Toll of methamphetamine on the trauma system" *Arch Surg.* 2004 Aug;139(8):844-7.