Poisoning Hospitalization Correlates with Poison Center Call Frequency

Timothy E. Albertson, MD, MPH, PhD[a,b,c], R. Steven Tharratt, MD, MPVM[a,b]
Kathy Marquardt, PharmD[a,b], Judith Alsop, PharmD[a,b], John K. Ninomiya, PhD[d],
Garrett E. Foulke, MD,[b,d]

[a]California Poison Control System, Sacramento Division, Sacramento, CA

[b]Division of Pulmonary and Critical Care Medicine, Department of Internal Medicine, University of California, Davis, School of Medicine, Davis, CA

[c]VA Northern California Health Care System, Mather, CA

[d]Milliman Care Guidelines, Seattle, WA

ABSTRACT

Introduction: Poison Control Centers (PCCs) have been shown to reduce health expenditures by reducing emergency department and clinic visits. The effect or association of PCC call frequency on acute hospitalization rates for poisonings has not been studied extensively.

Methods: All nonfederal hospital discharges for acute poisoning principal diagnosis codes (960–979, 980–989, 9956X, 3030, and 005) in California between October 1999 and June 2002 were examined. Approximately 3.3% of the discharges had county/hospital information suppressed in the public-use database because of confidentiality criteria and were excluded from the analysis. U.S. Census Bureau population estimates for appropriate years by counties were also obtained. The 58 California counties were condensed to 48 counties and 3 "small-county" geographic groupings. Exposure calls by counties/groupings to the California Poison Control System (CPCS) for the same period were tabulated.

Results: In California, rates of hospital discharges for poisoning averaged 0.54/1000 person years with a range of 0.25/1000 person years (Central Counties) to 1.53/1000 person years (Del Norte County). Poison call rates averaged 8.5/1000 person years with a range of 4.9/1000 person years (Los Angeles County) to 19.6/1000 person years (Napa County). Poisoning discharges per 1000 person years positively correlated with PCC calls per 1000 person years (Spearman correlation 0.41, $p = 0.0003$). The average hospital length of stay (LOS) did not correlate with PCC call frequency or poisoning discharges per 1000 person years.

Conclusion: The CPCS call frequency or county penetrance was not correlated with a reduction in the number of hospitalizations for poisoning nor was it associated with reduced average LOS in this study. Further study is needed to understand the etiology of the large differences in county rates of poisoning hospitalization and average LOS.

INTRODUCTION

Poisoning represents a significant health-care burden on the United States, with 28,700 poisoning deaths in 2003, of which 19.3% were intentional and 80.7% were unintentional and undetermined exposures. Intentional poisonings led to 279,802 emergency department (ED) visits; of these, 203,849 (72.8%) were hospitalized in 2004 [1]. Unintentional poisonings in the U.S. during this same time resulted in 577,886 ED visits with 25% of these visits leading to a hospitalization or transfer to another facility [1]. In

Keywords: poisoning, poison control centers, poison call frequency, poisoning hospitalization rates
Notes: Presented at the NACCT 2006 Meeting in San Francisco, CA
There was no outside funding of any kind used for this study.
Corresponding Author: Timothy E. Albertson, MD, MPH, PhD, Division of Pulmonary and Critical Care Medicine, School of Medicine, PSSB 3400, 4150 V Street, Sacramento, CA 95817, tealbertson@ucdavis.edu

2004, U.S. poison control centers (PCCs) reported 205,455 cases/calls of poison exposures from suicide attempts or assaults and about 2 million unintentional poison exposure cases/calls [2].

A host of studies and reports have found that PCCs reduce the expense of poisoning on the health-care system [3–11]. These estimates have come from a wide range of evidence including modeling and natural experiments in which services were disrupted or toll-free lines added [6,12,13]. For the most part, they have shown reduced total poisoning expenses based on reduced referrals to EDs and provider offices by the use of PCC management in which patients are observed at home [3,5,8–11]. In addition, hospital length of stay (LOS) has been shown to be reduced if a PCC is actively involved in management of the hospitalized poisoned patient [3,14]. There has been an assumption that PCCs reduce poisoning hospitalization rates. Polvika [15] noted "despite the belief that PCCs reduce hospitalization due to poisoning, data to support this has been elusive." A recent study, examining the penetrance of poison centers (calls per 1000 person years), found a reduction in poison admissions in rural U.S. counties in 12 states with increased use of PCCs [14]. The hypothesis that increasing use of or penetrance by a PCC is correlated with reduced poisoning-related hospital discharges was examined in California over a 33-month period. The specific assumption that increasing PCC penetrance in discrete geographical areas of California would correlate with decreased hospitalization rates in those areas was tested.

MATERIALS AND METHODS

All nonfederal hospital discharges for acute poisoning calls/cases were correlated with PCC acute calls during a 33-month period. Because the California Poison Control System (CPCS) is the only PCC for the state of California, we were able to collect data on all the PCC calls for the state during the study interval. The CPCS database of poison exposure phone calls (Visual Dot Lab) from October 1, 1999 to June 31, 2002 were retrieved. All patient identifiers were removed. The exposure calls were categorized by the California county of origin and date of call. Several of the smaller counties were combined geographically so that the 58 total California counties were condensed into 48 actual counties and 3 "county groupings" for analysis. Thus a total of 51 California geographic categories or groupings were used in the study.

For the same time frame of October 1, 1999 to June 30, 2002, all nonfederal hospital discharges for acute poisonings with principal diagnosis codes (960–979, 980–989, 9956X, 3030, and 005) in California were obtained from the California Office of Statewide Health Planning and Development. These public data were blinded. In addition, about 3.3% of all discharges were excluded from analysis because the public-use database suppressed the county/hospital information to protect the privacy of patients who might be identifiable based on the combination of hospital, date, and demographic information. The poisoning discharges from hospitals were categorized by hospital location into one of the 51 California geographic groupings for analysis.

Hospitalization rates and PCC call rates were calculated using the data above and U.S. Census Bureau population estimates of population by county or county grouping for the appropriate years studied. Statistical analysis was performed using Spearman Rank Correlation Tests.

Institutional Human Subject Reviews and approvals were obtained from the University of California, San Francisco (home of the CPCS) and the University of California, Davis.

RESULTS

During the 33 months studied, there were 50,920 identified primary poison discharges from nonfederal hospitals in California representing 132,173 patient hospital days. Hospitalization rates for acute poisoning averaged 0.54/1000 person years with a range of 0.25/1000 person years for Central Counties Grouping to 1.53/1000 person years for Del Norte County (*Table 1*). The average LOS was 2.6 days with a range of 1.7 days in the Northeastern Counties Grouping to 3.6 days for Napa County (see *Table 1*).

There were 188 different poisoning diagnoses for the hospital discharges. Forty-one of the specific poisoning diagnoses had only 1 hospital discharge associated with them. *Table 2* lists the top 10 diagnoses associated with hospital discharge during the study period in California.

A total of 801,640 acute poisoning/exposure calls were received by the CPCS during the period of analysis. Poison call rates averaged 8.5/1000 person years with a range of 4.9/1000 person years for Los Angeles County and 19.6/1000 person years for Napa County (*Table 1*).

Using Spearman rank correlation tests, acute poisoning discharges per 1000 person years were positively correlated with poison calls per 1000 person years by county/county groupings (Spearman correlation of 0.41, $p = 0.003$). Acute poisoning average LOSs were not correlated with poison calls per 1000 person years or acute hospital discharges for poisoning per 1000 person years.

DISCUSSION

Variations in the use and frequency of exposures reported to PCC have been previously noted. Both regional and seasonal variations have been reported by several investigators [16–21] with a significant predominance in summer to early fall repeatedly seen. Some of the variation in utilization of PCCs can be attributed to sociodemographic factors with lower uses in areas with lower population density, higher African American and Hispanic/Latino populations, lower median household income, lower density of children, and homes in which languages other than English are spoken [22–26]. The current study further demonstrates regional variations in both exposure calls to the CPCS and acute hospital discharges for poisoning.

Previous literature has suggested that each 1% increase in PCC penetrance or call rates in rural counties was associated with a 0.19% lower hospitalization rate among people who visited the ED because of poisoning [14]. The opposite association

Table 1: County and County Grouping with Poison-Related Hospital Discharges, Average Length of Stay (ALOS), Poison Center Calls (1000 Person Years) and Hospital Discharges (1000 Person Years)

County	Person-Years	Discharges	Days	ALOS	Calls	Call/1000	Disch /1000
Del Norte	75,276	115	305	2.7	899	11.94	1.53
Lake	164,199	244	526	2.2	2761	16.81	1.49
Shasta	458,205	557	17621	3.2	6081	13.27	1.22
Butte	562,876	666	1626	2.4	7861	13.97	1.18
Yuba	167,785	176	476	2.7	2532	15.09	1.05
Tehama	155,303	161	383	2.4	1851	11.92	1.04
Humboldt	347,085	342	991	2.9	5538	15.96	0.99
Nevada	256,978	244	510	2.1	3312	12.89	0.95
Mendocino	238,192	211	543	2.6	3352	14.07	0.89
Amador Country	97,987	86	152	1.8	1228	12.53	0.88
San Luis Obispo	683,846	494	1114	2.3	7488	10.95	0.72
Tuolume	151,427	107	228	2.1	2097	13.85	0.71
Sacramento	3,443,774	2266	5609	2.5	52377	15.21	0.66
Sonoma	1,269,114	823	2071	2.5	15708	12.38	0.65
San Francisco	2,118,830	1341	3988	3	24287	11.46	0.63
Stanislaus	1,264,464	797	2452	3.1	15847	12.53	0.63
San Joaquin	1,608,409	990	2288	2.3	17064	10.61	0.62
Siskiyou	121,380	74	159	2.1	1447	11.92	0.61
Calaveras	114,088	68	152	2.2	12.61	11.05	0.60
El Dorado	441,818	263	683	2.6	8283	18.75	0.60
Riverside	4,410,771	2586	6411	2.5	33661	7.63	0.59
San Bernadino	4,806,615	2776	6974	2.5	36443	7.58	0.58
San Diego	7,836,42	4354	11127	2.6	96944	12.37	0.56
Monterey	1,110,151	613	1360	2.2	6635	5.98	0.55
Contra Costa	2,658,133	1454	4125	2.8	24748	9.31	0.55
Santa Cruz	699,119	379	809	2.1	7851	11.23	0.54
Santa Barbara	1,099,019	590	1296	2.2	7932	7.22	0.54
Alameda	4,006,796	2114	5624	2.7	34880	8.71	0.53
Solano	1,102,938	580	1287	2.2	14087	12.77	0.53
Orange	7,906,979	4057	9357	2.3	54006	6.83	0.51
Imperial	395,421	201	486	2.4	2354	5.95	0.51
Sutter	220,059	110	310	2.8	2065	9.38	0.50
Placer	715,578	355	959	2.7	10144	14.18	0.50
Los Angeles	26,416,681	13083	35794	2.7	130283	4.93	0.50
Madera	343,138	165	381	2.3	4115	11.99	0.48
Kern	1,846,793	887	2575	2.9	15651	8.47	0.48
Yolo	473,061	221	606	2.7	6326	13.37	0.47
Fresno	2,223,645	1038	3001	2.9	28,007	12.60	0.47
Ventura	2,102,439	950	2564	2.7	13779	6.55	0.45

Table 1: (Continued)

County	Person-Years	Discharges	Days	ALOS	Calls	Call/1000	Disch /1000
Santa Clara	4,625,481	2062	4852	2.4	24460	5.29	0.45
Kings	359,836	158	315	2	3251	9.03	0.44
San Mateo	1,942,014	844	2357	2.8	17108	8.81	0.43
Northeastern	92,699	40	67	1.7	1202	12.97	0.43
Marin	678,859	289	796	2.8	7878	11.60	0.43
Tularie	1,023,208	433	1144	2.6	9387	9.17	0.42
Lassen	92,504	38	78	2.1	1245	13.46	0.41
San Benito	149,516	61	154	2.5	1075	7.19	0.41
Merced	592,508	234	684	2.9	5139	8.67	0.39
Napa	347,575	136	489	3.6	6804	19.58	0.39
Northwestern Countries	161,130	54	113	2.1	1433	8.89	0.34
Central Countries	134,633	33	60	1.8	1473	10.94	0.25

Table 2: Top Ten Most Common Poisoning Diagnoses—Hospital Discharges

Diagnosis Code	Diagnosis	Number Cases
9694	Benzodiazepine-based tranquilizers	614
9690	Antidepressants	507
96509	Opiates and related narcotics	474
9654	Aromatic analgesics (acetaminophen)	471
0059	Food poisoning, unspecified	351
9895	Toxic effect of venom	299
96561	Proprionic acid derivatives (nonsteroidals)	221
9630	Antiallergic and antiemetics	209
9651	Salicylates	182
96500	Opium (alkaloids), unspecified	181

was suggested in this study where increasing penetrance or call rates were positively associated with increased poisoning related hospital discharges. Previous studies have shown that rural populations self-refer to a health-care facility more than urban populations for poisoning. The current study did not look specifically at ED visits and resulting hospitalizations but at all poison-related discharges. Further, using the US Department of Agriculture definition of rural that was used by Zaloshnja et al. [14,27], only seven of the 58 counties in California met this definition (Alpine, Del Norte, Injo, Mariposa, Mano, Sierra and Siskijo) with a total population of only 24,499 (0.3% of total California population). Thus, if a specific "rural" county effect to lower hospitalizations due to poisoning by using a PCC exists, it would be hard for this effect to be seen with such a small percentage of patients meeting this rural definition in the current study.

The hospitalization discharge rates for poisoning (average of 0.54/1000 person years) seen in this study are consistent with hospitalization rates for pediatric (<18 years old) intoxications (0.45/1000 person years) seen in the State of Washington [28]. The distribution of the agents involved in the Washington study was similar to those found in this study (see *Table 2*) with antidepressants, salicyclates, antiallergens and antiemetics, ethanol, anticonvulsants, benzodiazepines, stimulants/amphetamines, antiasthmatics, and antibiotics representing the top ten in the Washington State study [28]. The call penetrance reported in the current study (average of 8.5 calls/1000 person years) is very similar to that seen in a study of rural counties (8.13–8.21 calls/1000 person years) [14].

PCC call penetrance was also not associated with hospital LOS for poisoning in the current study. This contrasts with the finding that hospital poison cases followed by a PCC had a shorter LOS than those matched cases not followed by a PCC [29]. In the current study, the cases were blinded in each data set, therefore we were unable to evaluate whether hospital cases that were managed specifically by the CPCS had shorter LOS than those not directly followed. No overall correlation with call penetrance was found.

The average LOS of 2.6 days found in the current study was also consistent with the median LOS of 2 days with active PCC case participation compared to 5 days without active PCC participation in poison cases that has been previously reported [30]. A median LOS for hospitalized poisoning cases of between 1 and 2 days was also reported in the pediatric study in the state of Washington [28]. Further, this range is consistent with Woolf [31], who reported a decline in mean LOS for pediatric poisoning from 5.85 days in 1992 to 3.45 days ($p = 0.005$) in 1995.

This study demonstrated large variations between counties in rates of both hospital discharges for poisoning and corresponding acute poison calls to the CPCS, the sole PCC for California. The size and diversity of California, the lack of detailed information about the demography of the patients in this study, and the inability to track whether the PCC was involved in the care of the hospitalized poisoned patients limit conclusions. In looking for correlation, the lack of counties without PCC coverage further limits this study. An additional limitation includes the inability to connect the databases directly to specific poison patients (blinded databases) to see if the PCC was called before or after a specific poison admission. Hospital discharge databases are limited by the quality and extent of discharge coding. Further sociodemographic analysis is needed to potentially explain the large variations in PCC penetrance and poisoning hospitalization rates seen in this study. Using this data, there was no evidence that higher use of PCCs results in lower poison-related hospital discharges.

REFERENCES

1. National Centers for Injury Prevention and Control [webpage on the Internet]. Poisoning in the United States: Fact Sheet (NCIPC). 2008 [cited 2008 Jan 1]. Available from: http://www.cdc.gov/ncipc/factsheets/poisoning.htm.

2. Watson WA, Litovitz TL, Rodgers GC Jr, Klein-Schwartz W, Reid N, Youniss J, et al. 2004 Annual report of the American Association of Poison Control Centers Toxic Exposure Surveillance System. *Am J Emerg Med* 2005;23(5):589–666.

3. Miller TR, Lestina DC. Costs of poisoning in the United States and savings from poison control centers: a benefit-cost analysis. *Ann Emerg Med* 1997;29(2):239–245.

4. Darwin J, Seger D. Reaffirmed cost-effectiveness of poison centers. *Ann Emerg Med* 2003;41(1):159–160.

5. Stremski ES. Accidental pediatric ingestion, hospital charges and failure to utilize a poison control center. *WMJ* 1999;98(7):29–33.

6. Phillips KA, Homan RK, Hiatt PH, Luft HS, Kearney TE, Heard SE, et al. The costs and outcomes of restricting public access to poison control centers. Results from a natural experiment. *Med Care* 1998;36(3):271–280.

7. Phillips KA, Homan RK, Luft HS, Hiatt PH, Olson KR, Kearney TE, et al. Willingness to pay for poison control centers. *J Health Econ* 1997;16:343–357.

8. King WD, Palmisano PA. Poison control centers: can their value be measured? *South Med J* 1991;84(6):722–726.

9. Kearney TE, Olson KR, Bero LA, Heard SE, Blanc PD, Health care cost effects of public use of a regional poison control center. *West J Med* 1995 Jun;162(6):499–504.

10. Kelly NR, Ellis MD, Kirkland RT, Holmes SE, Kozinetz CA. Effectiveness of a poison center: impact on medical facility visits. *Vet Hum Toxicol*, 1997;39(1):44–48.

11. Chafee-Bahamon C, Lovejoy FH Jr. Effectiveness of a regional poison center in reducing excess emergency room visits for children's poisonings. *Pediatrics* 1983;72(2):164–169.

12. Marcus SM, Chafee-Bahamon C, Arnold VW, Lovejoy FH Jr. A regional poison control system. Effect on response to hypothetical poisonings. *Am J Dis Child* 1984;138(11):1010–1013.

13. Harrison DL, Draugalis JR, Slack MK, Langley PC. Cost-effectiveness of regional poison control centers. *Arch Intern Med* 1996;156(22):2601–2608.

14. Zaloshnja E, Miller T, Jones P, Litovitz T, Coben J, Steiner C, et al. The potential impact of poison control centers on rural hospitalization rates for poisoning. *Pediatrics* 2006;118(5):2094–2100.

15. Polivka BJ, Elliott MB, Wolowich WR. Comparison of poison exposure data: NHIS and TESS data. *J Toxicol Clin Toxicol* 2002;40(7):839–845.

16. Paulozzi LJ. Seasonality of reported poison exposures. *Pediatrics* 1983;71(6):891–893.

17. Eskola J, Poikolainen K. Seasonal variation and recurring peaks of reported poisonings during a 3-year period. *Hum Toxicol* 1985;4(6):609–615.

18. Greenberg RS, Osterhout SK. Seasonal trends in reported poisonings. *Am J Public Health* 1982;72(4):394–396.

19. Vassilev ZP, Marcus SM. Seasonal changes in poisoning exposures reported to a regional poison center from coastal resort areas. *J Toxicol Environ Health A* 2005;68(5):315–318.

20. Albertson TE, Tharratt RS, Alsop. J, Marquardt K, Heard S. Regional variations in the use and awareness of the California Poison Control System. *J Toxicol Clin Toxicol* 2004;42(5):625–633.

21. Afshari R, Majdzadeh R, Balali-Mood M. Pattern of acute poisonings in Mashhad, Iran 1993–2000. *J Toxicol Clin Toxicol* 2004;42(7):965–975.

22. Forrester MB. Association between sociodemographic factors and exposures and utilization of poison centers in Texas, 1998–2002. *J Toxicol Environ Health A* 2005;68(10):755–761.

23. Wolowich WR, Casavant MJ, Fisher CA. Age-specific and age-adjusted penetrance as poison center outcome measures. *J Toxicol Clin Toxicol* 2001;39(4):367–370.

24. Clark RF, Phillips M, Manoquerra AS, Chan TC. Evaluating the utilization of a regional poison center by Latino communities. *J Toxicol Clin Toxicol* 2002;40(7):855–860.

25. Kelly NR, Groff JY. Exploring barriers to utilization of poison centers: a qualitative study of mothers attending an urban Women, Infants, and Children (WIC) Clinic. *Pediatrics* 2000;106(1 Pt 2):199–204.

26. Vassilev ZP, Marcus S, Jennis T, Ruck B, Swenson R, Rego G. Rapid communication: sociodemographic differences between counties with high and low utilization of a regional poison control center. *J Toxicol Environ Health A* 2003;66(20):1905–1908.

27. US Department of Agriculture, Economic Research Service Data Sets: Rural-urban continuum codes [updated 3 November 2004; cited 2008 Jan 15]. Available from: www.ers.usda.gov/data/ruralurbancontinuumcodes.

28. Gauvin F, Bailey B, Bratton SL. Hospitalizations for pediatric intoxication in Washington State, 1987–1997. *Arch Pediatr Adolesc Med* 2001;155(10):1105–1110.

29. Vassilev ZP, Shiel M, Lewis MJ, Marcus SM, Robson MG. Assessment of barriers to utilization of poison centers by Hispanic/Latino populations. *J Toxicol Environ Health A* 2006;69(18):1711–1718.

30. Vassilev ZP, Kashani J, Ruck B, Hoffman RS, Marcus SM. Poison control center surge capacity during an unusual increase in call volume—results from a natural experiment. *Prehosp Disaster Med* 2007;22(1):55–58.

31. Woolf A, Wieler J, Greenes D. Costs of poison-related hospitalizations at an urban teaching hospital for children. *Arch Pediatr Adolesc Med* 1997;151(7):719–723.