Human Plant Exposures Reported to a Regional (Southwestern) Poison Control Center over Eight Years

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Abstract

Background: There is little published data about human plant exposures reported to US poison control centers (PCC). A review of PCC records was performed to better understand the characteristics of these calls. Methods: Retrospective chart review of a single PCC's cases received between 1/1/03 and 12/31/10. Specific generic plant codes were used to identify cases. Calls unrelated to human exposures were excluded. Recorded variables included: patient demographics, plant involved, exposure variables, symptoms, management site, treatments and outcome. Odds ratios (ORs; all p's < 0.001) were determined for clinical effects and hospital admission. Results: A total of 6,492 charts met inclusion criteria. The average patient age was 16.6 years (2 months - 94 years); 52.4% were male. The most common exposure reason was unintentional (98%), and the majority (92.4%) occurred at the patient's home. Ingestions (58.3%) and dermal exposures (34.3%) accounted for most cases. Cactus (27.5%), oleander (12.5%), *Lantana* (5.7%) and *Bougainvillea* (3.8%) were most commonly involved. Symptoms developed in 47.1% of patients, and were more likely to occur following *Datura* (66.7%), and Morning Glory or Milkweed (25% each) exposures. Almost 94% of patients were managed onsite (home) and only 5.2% involved evaluation in a health care facility (HCF). The most common treatments were: fluids (57.7% of cases), local wound care (31.1%) and ocular irrigation (4.4%). Only 37 (0.6%) patients required hospital admission, and 2.9% of cases resulted in more than minimal effects. Exposures resulting in more than minimal clinical effects were predicted by several variables: abnormal vital signs (OR=35.62), abnormal labs (OR=14.87) and management at a HCF (OR=7.37). Hospital admissions were increased for patients already at a HCF (OR=54.01), abnormal vital signs (OR=23.28) and intentional exposures (OR=14.7).

Conclusions: Plant exposures reported to our poison center were typically unintentional ingestions occurring at home. Most patients were managed onsite and few developed significant symptoms.

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Background

In 2015 there were 46,597 human plant exposures called to US poison control centers (PCCs) which represented 1.8% of all exposure calls.[1] This made plants the 21st most common substance category involved in human exposures, and approximately (~) 60% (n=28,213) of these calls involved pediatric patients under the age of 6 years. Unfortunately, there is a common misperception that all plant exposures are benign, despite educational efforts aimed at medical professionals.[2-5]

There is, however, little published data about plant calls to PCCs and none for the state of Arizona.[6-17] Although the proportion of plant-related calls to PCCs has decreased over the last 25 years, the continued frequency of these cases represent a strain on the healthcare system. A better understanding of outcomes following plant ingestions may improve patient management and prevent unnecessary evaluations in a health care facility (HCF). With this goal, a review of the records from an urban PCC, in the Southwestern US, was performed to better understand the characteristics of human plant exposures.

Method

A retrospective review was performed on all human plant exposure calls to a single, urban PCC between January 1, 2003 and December 31, 2010. All charts within the PCC's electronic medical record system (EMR) were searched using Visual Dot Lab Enterprise® (version 4.6.2; 2017). Plant-specific generic (numerical) codes, established by the American Association of Poison Control Centers' (AAPCC) National Poison Data System (NPDS), were used to identify cases. A total of 16 NPDS codes (e.g. 0088000 for 'amygdalin and/or cyanogenic glycosides') were used to search the EMR for all plant calls during the eight-year study period. Calls unrelated to human exposures were excluded.

All identified cases were manually reviewed by trained researchers who recorded information from the charts into a standardized electronic data abstraction form using Microsoft Excel® (97-2003 worksheet). Recorded variables included: patient demographics (gender and age), plant(s) involved, NPDS code, exposure variables (location, route and reason of exposure), symptoms, management site, treatments and outcome. Clinical effects and patient outcomes were recorded by using established NPDS coding parameters (NPDS Coding User's Manual© version 3.1; approved 5/7/14).

Descriptive statistics were used on continuous variables and reported as means with standard deviation and range. Individual analyses of categorical variables are reported with percentages based on the total number of cases with complete data. Univariate and multivariate regression was used to identify outcome predictors. Univariate predictors with $p < 0.10$ were entered into multiple regression using the forward LR method (IBM SPSS for MAC v.24.0; Armonk, NY) for analysis.

A total of 79 (1.2%) cases were coded as "unable to follow" but contained sufficient outcome data to be included in analysis. Individual data points (e.g. gender) were missing for some charts. For missing data, we used case-wise deletion for all variables/outcome analyses.

A random sample of 100 (1.5%) charts was reviewed by a second investigator to ensure accuracy of data abstraction. This re-analysis found a recording accuracy of 98.4% for 1600 reviewed data points. This study received approval from our institution's investigational review board.

Results

The PCC received 823,489 total calls between 1/1/03 and 12/31/10; of these, 6,492 (0.79%) met inclusion criteria for human plant exposures. The average patient age was 16.6 years (SD 21.7 years; range: 2 months - 94 years) and most (52.4%) were male. Almost 93% of the exposures occurred at a home; either the patient's (92.4%) or another (0.4%) residence. The locations for all plant exposures are reported in table one.

The ten most commonly involved plants are listed in table two, and included cactus (27.5%), oleander (12.5%), *Lantana* (5.7%), *Bougainvillea* (3.8%) and *Philodendron* (2.2%); 3.2% of cases involved an unknown plant. A complete list of all reported plant types/species with corresponding frequencies is available in the supplemental file (appendix 1).

The most common route of exposure was ingestion and accounted for 58.3% of all cases. Dermal (34.3%), ocular (5.7%), inhalational (0.6%), parenteral (0.01%; n=1) and combined routes of exposure were also recorded (table three). The most common reason for exposure was unintentional (98%). All exposure reasons are listed in table four.

A total of 3,168 (48.4%) charts had clinical signs and/or symptoms coded within the EMR, but only 3,059 (47.1% of all case) were attributed to the plant exposure. The most commonly reported (attributable) signs/symptoms were: 'puncture' (n=1,489); 'throat' or 'tongue irritation' (n=753), 'rash/redness' (n=634), 'vomiting' (n=437) and 'ocular' irritation (n=203).

Table One. Exposure location for human plant cases reported to a PCC.

Location	Number of Calls (% of total)
Own residence	5,995 (92.4%)
School	284 (4.4%)
Public place	164 (2.5%)
Other residence	28 (0.4%)
Workplace	17 (0.3%)
Total calls with coded data n= 6,488 (99.94%)	

Table Two. Most common plants involved in human exposures reported to a PCC

Rank	Plant / Species	% of Total Calls
1	Cactus	27.5
2	*Oleander* spp.	12.5
3	*Lantana* spp.	5.7
4	*Bougainvillea* spp.	3.8
5	Unknown	3.2
6	*Philodendron* spp.	2.2
7	Pothos (*Epipremnum* spp.)	1.9
8	Poinsettia	1.7
9	*Pyracantha* spp.	1.7
10	*Ficus* spp.	1.6

Table Three. Routes of human plant cases reported to a PCC.

Route of Exposure	Number of Calls (% of total)
Ingestion	3,786 (58.3%)
Dermal	2,223 (34.3%)
Ocular	367 (5.7%)
Dermal and other*	61 (0.9%)
Inhalation	42 (0.6%)
Inhalational and other*	5 (0.07%)
Other*	4 (0.06%)
Parenteral	1 (0.01%)
Total calls with coded data n= 6,489 (99.95%)	

*Other include: nasal, ear, intra-oral (but not ingested), mucous membranes.

Table Four. Reason for plant exposures reported to a PCC.

Reason for Exposure	Number of Calls (% of total)
Unintentional (accidental)	6,362 (98%)
Misuse / Self-harm	75 (1.2%)
Recreational	41 (0.6%)
Unknown	6 (0.1%)
Total calls with coded data n= 6,484 (99.87%)	

All coded effects (patient outcomes) are reported in table five. Only 188 (2.9%) cases resulted in greater than minimal clinical effects: moderate (n=179) and major (n=9). The nine (0.1%) coded major effects including one death (described below) and the following two cases. Case 1: A 32-year-old suffered an anaphylactic reaction to Jimsonweed (*Datura stramonium*) while gardening. The patient was admitted to intensive care (ICU) for airway edema and respiratory distress but made a complete recovery with pharmacotherapy. Case 2: A 43-year-old developed bradycardia and hypotension after a suicidal ingestion of tea brewed from oleander leaves/fruit. The patient had nausea, vomiting and diarrhea; bradycardia (heart rate in the 40s) and hypotension (systolic pressure in the 90s); a (false-positive) serum digoxin concentration (peak 0.9 ng/mL) and normal serum potassium (K^+=4.3 mEq/L). After an ICU admission the patient made a complete recovery in 48 hours without requiring digoxin-specific antibody.

There was one recorded death during the eight-year study period involving a 34-year-old patient with a witnessed (intentional) yohimbe ingestion. After the ED physician described the patient to PCC staff, a salicylate level (and appropriate treatment) were recommended. The initial salicylate concentration was 115 mg/dL; despite appropriate interventions the patient died within four hours of presentation. The exact role that yohimbe played in this case was unknown, but the death was primarily attributed to acute salicylate toxicity.

Symptoms were most likely to occur following *Datura* (66.7%), Morning Glory or Milkweed (25% each), and Pencil cactus (18.2%) exposures. Interestingly, only 2.6% (25 out of 927) of all other (non-pencil) cacti exposures developed symptoms (see table six).

Table Five. Outcomes (clinical effects) for plant exposures reported to a PCC.

Patient Outcome (clinical effect)	**Number of Calls (% of total)**
Non-toxic exposure	741 (11.4%)
No effect	1,246 (19.2%)
Minor	360 (5.5%)
Moderate	179 (2.8%)
Major	9 (0.1%)
Death (judged as unrelated to plant exposure)	1
Unrelated (effects not related to exposure)	194 (3.0%)
Unable to follow (lost to follow up)	79 (1.2%)
Total calls with coded data n= 6,489 (99.95%)	

Table Six. Plants exposures resulting in moderate or major symptoms.

Plant Type/Species	**Patients with Moderate/Major Symptoms** (Case / Total number of calls)	**Percentages**
Datura spp.	14/21	66.7%
Morning Glory	2/8	25%
Milkweed	2/8	25%
Pencil Cactus	48/263	18.2%
Aloe	4/39	9.3%
Mexican Bird of Paradise	4/46	8%
Palm	4/89	4.3%
Poison Ivy	2/46	4.2%
Oleander	29/762	3.7%
Other Cactus (NOS)	25/927	2.6%

Abnormal vital signs (related to the exposure) were coded in only 18 (0.3%) cases. These included: tachycardia (n=11); bradycardia (n=4); hypotension (n=4); hyperthermia (n=3); and hypertension or tachypnea (n=1 each). Laboratory abnormalities were coded in 15 (0.2%) of all cases. Lab anomalies, attributable to the plant exposure included: rhabdomyolysis (n=6); measureable blood digoxin concentration (n=6); positive urine drug screen (n=3); acidosis or hyperglycemia (n=2 each); and one abnormal EKG (incomplete right bundle-branch block).

The most common treatments were: providing fluids (57.7% of cases), local wound care (31.1%) and ocular irrigation (4.4%). The vast majority (93.8%) of patients were managed (received treatments) onsite, which was usually the patient's home, and only 5.2% involved evaluation in a HCF (table seven). Only 37 (0.6%) patients required hospital admission. All admitted patients made complete recoveries other than the one death described above.

Multiple logistic regressions were used to identify independent predictors for two outcomes: (1) development of moderate/major clinical effects (compared to minimal or no effects), and (2) need for hospital admission. The ORs for these variables were determined based on unadjusted, univariate analysis for each outcome (tables 8 and 9, respectively) and reported with 95% confidence intervals (CI).

The development of more severe (moderate or major) clinical effects, compared to minor effects, was associated with several variables. These included abnormal vital signs, OR=35.62 (95% CI: 7.69-165.1); abnormal laboratory data, OR=14.87 (95% CI: 3.42-64.7); management site (at a HCF prior to PCC contacted), OR=7.37 (95% CI: 5.08-10.7); and age, with an increased OR=1.02 for each increased year of age (95% CI: 1.01-1.03). Interestingly, patients with inhalation or ingestion exposures were less likely to develop > minor effects (OR=0.56; 95%CI: 0.37-0.87) compared to all other exposure routes.

Hospital admission was increased for several variables, including: management site (HCF compared to a non-HCF), OR=54.01 (95% CI: 17.3-168.2); abnormal vital signs, OR=23.28 (95% CI: 4.94-109.6); and intentional or recreational exposures, OR=14.7 (95% CI: 5.97-36.2).

Table Seven. Patient management site following plant exposures.

Management Site	Number of Calls (% of total)
On site (site of exposure; e.g. home)	6,088 (93.8%)
Health Care Facility	336 (5.2%)
Other (e.g. school, work, public place)	37 (0.6%)
Total calls with coded data n= 6,489 (99.95%)	

Table Eight. Multiple regression: Developing > Minor Clinical Effects**.** *

Variable	Odds Ratio (95% CI)
Abnormal vital signs (attributed to the exposure)	35.62 (7.69-165.1)
Abnormal laboratory data (attributed to the exposure)	14.87 (3.42-64.7)
Management Site (in a HCF compared to non-HCF sites)	7.37 (5.08-10.7)
Age (increase/yr)	1.02 (1.01-1.03)
Route of exposure (inhalation/ingestion v. all other routes)	0.56 (0.37-0.87)

* All values are statistically significant; $p < 0.001$.

Table Nine. Multiple regression: Hospital Admission. *

Variable	Odds Ratio (95% CI)
Management Site (in a HCF compared to non-HCF sites)	54.01 (17.3-168.2)
Abnormal vital signs (attributed to the exposure)	23.28 (4.94-109.6)
Reason for Exposure [Intentional (recreational/self-harm) compared to unintentional and all other exposures.]	14.7 (5.97-36.2)

* All values are statistically significant; $p < 0.001$.

Discussion

All PCCs answer calls 24-hours day from the public and medical professionals concerning exposures to (or questions about) medications, chemicals and environmental agents (e.g. plants and venomous creatures). Poison centers are staffed by specialists in poisoning information (nurses or pharmacists) and poison information providers who received specialized training (and sometimes national certification) in poisoning emergencies. Since staff make triage decisions based on telephonic (unverifiable and often limited) information, a better understanding of epidemiological outcomes for specific call types may assist with optimal treatment recommendations.

Several previous studies have reviewed PCC databases to describe patient outcomes following plant exposures. These data showed that most exposures result in minimal effects, and that children are more likely to be involved in serious clinical effects, including death (e.g. a pokeweed-related death in 2008).[7,14,15] A Czech Republic study found that 50% of plant exposures resulted in symptoms, most commonly gastrointestinal (nausea, emesis or diarrhea) or neurologic (non-specific; up to 33%).[13] While serious adverse effects may be rare, it is important to educate the public about potentially toxic plants (based on geographic area) in hopes of preventing exposures and adverse effects. Likewise, health care providers also require knowledge about the implications of plant exposures.

Previous studies have shown a lack of plant knowledge among Emergency Department (ED) physicians.[18,19] For example; 56 physicians were asked to identify 12 common household plants, but only 17% of plants were identified by name, and fewer (13%) were correctly identified based on toxicity.[18]

Arizona's desert climate and increased access to irrigation water has prompted the growth of both endemic (e.g. cactus) and transplanted (e.g. oleander) species, include potentially poisonous varieties. And many toxic species (e.g. oleander and Jimsonweed) are more commonly found in Arizona than in other areas of the US. This fact, combined with a rapidly growing urban population, may explain the differences between our (regional) findings and national results. On a national level, Unknown (plant/botanical name), *Phytolacca*, toxicodendrol-containing (skin irritants) and Cherry (cyanogenic) *species* were the most common categories of plants involved in human exposures (table 20; AAPCC's Annual Report)[1]. The larger percentage of unknowns among the national data is probably due to increased plant diversity but may also have been affected by differences in coding between PCCs.

Knowing what the most common plant exposures are for the southwestern US may provide opportunities for preventing unintentional exposures. Since PCCs and toxicologist are tasked with providing appropriate medical advice, while preventing unnecessary medical evaluations, it is important to understand the potential outcomes of specific plant exposures. This knowledge may also affect how medical toxicologists assist with patient disposition following ED presentation. These data suggest that several variables might be monitored when attempting to predict the development of significant clinical effects (i.e. abnormal vital signs and laboratory results), or need for hospital admission (i.e. intentional exposures, abnormal vital signs and need for HCF management). Several of the reported ORs were limited by wide confidence intervals (due to small sample sizes). Finally, the significant ORs indicate association, and not necessarily causation.

There are limitations with all retrospective PCC-based studies, including the potential for reporting bias (e.g. only being called about symptomatic patients) and accuracy of reported and coded data. Unfortunately, the information coded in our charts could not be independently verified. Also, abstractors were not blinded to the purpose of this work and may have interpreted data in a biased manner. Some calls were excluded due to callers refusing our recommendations (not going to an ED) or follow-up attempts; other calls were simply lost to follow-up. The outcomes of these cases were unknown and may have affected findings. Inevitably, some plant exposures were not reported to our PCC, including some that involved evaluation at a HCF.

Conclusions

Human plant exposures, reported to a single Southwestern US poison center, were typically unintentional ingestions occurring at home. The majority of patients were managed onsite and few developed more than minor symptoms. The development of significant clinical effects, and need for hospital admission, were each associated with several variables.

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