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Assessing unnecessary emergency department visits for poison exposures in pediatric patients less than six years old

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ABSTRACT

Introduction: We will investigate the medical necessity of pediatric emergency department presentations, specifically for emergency department poison cases where a poison control center was not contacted prior to presenting.

Methods: A retrospective analysis of 348 poison control center cases involving patients aged < six, originating from a healthcare facility were evaluated. Toxicologists were presented with case summaries and were asked: "would you send this patient to the emergency department?" Evaluators answered on a 4-point Likert scale from "definitely would not send" to "definitely would send." Reviewers had the opportunity to write in additional information that would be beneficial to deciding their disposition. To simulate the need to make a yes or no decision on whether to send, Likert scores were manipulated into a binomial score of 0/1. Binomial regression analysis and qualitative thematic analysis were completed.

Results: Toxicologists found that 38% of patients definitely did not require emergency department evaluation, and 27% were unlikely to require it. The presence of clinical symptoms were significantly associated with increased concern by toxicologists. Qualitative analysis from reviewer free text case comments, demonstrated that understanding the situation surrounding the exposure (certainty, past medical history, etc. $n=26$) and presence of specific symptoms in each case (fever, vomiting, etc. $n=25$) were desired to better determine the need for an emergency department.

Discussions: About 65% of cases were evaluated as not requiring emergency department evaluation. The presence of clinical symptoms is a key factor related to clinician level of concern. Further work should include finding ways to prevent these emergency department presentations.

Conclusions: Many emergency department evaluations for poison exposure amongst children less than six years old are not medically required. Further work should focus on improving parental knowledge of poison centers and poison safety, while continuing to promote poison centers as accessible resources to the public.

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Introduction

In 2022, 98 children less than five years old died by a poison exposure, with an estimated 64,900 total emergency departments (ED) visits for poisoning for this age group within the United States [1]. Children brought to the ED for evaluation exact a burden on both the healthcare system and families. Poisoned children brought to the ED are three times more likely to arrive *via* Emergency Medical Services, five times more likely to be triaged for immediate evaluation by an ED provider, and three times more likely to be

admitted to the ICU when compared to all other patients presenting to the ED [2].

Outside of resource usage and manpower associated with visits, the financial burden for both families and the healthcare system can be significant. The mean hospital bill for each ED visit for pediatric poisoning in 2008 was noted to be \$1,077 with a mean estimated duration of hospitalization of 1.9 days [3]. These are time-consuming for families, lead to increased wait times, and carry an increased risk of exposure to infectious disease. Many end up being

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discharged. Thus, there are multiple potential benefits to preventing these unneeded visits.

Poison control centers (PCC) were developed in the 1950s after the American Academy of Pediatrics pushed for the creation of a centralized source of information relating to potentially toxic drugs and chemicals [4,5]. Fifty-three PCCs currently exist in the United States providing 24/7/365 verified medical information to patients and their families regarding poisons, in addition to providing healthcare professionals advice on medical management for the poisoned patient. According to the 2022 Annual Report of the National Poison Data System® there were 2,064,875 human poison exposures managed by PCCs [6]. Children less than six years old accounted for 830,754 (40.23%) of these cases.

A 2008 study suggests that each call to a PCC could yield a net healthcare savings of approximately \$203 dollars (estimated to be \$334 in 2022 per the US Bureau of Labor Statistics Consumer Price Index Inflation Calculator) for each patient that calls and avoids an ED visit after being triaged to home [7]. When accounting for the estimated 64,900 children aged five and below evaluated in the ED in 2022 for poison exposure, this would amount to \$13,174,700 annual savings based on the \$203 per visit, or \$16,286,673.04 when accounting for inflation. Poison Centers, when utilized correctly, offer significant benefit to healthcare spending, with an overall benefit-cost ratio of 1.4 [7].

A 1983 study investigated PCCs role in mitigating unnecessary hospital evaluations[8]. Of patients who did not contact a PCC prior to presenting, a panel of toxicologists deemed that 63% did not require hospital services and could have remained at home. For those who did first call, only 1% of these parents were advised to present to the ED [8]. In 2020, a study similarly investigated self-referrals to the ED and determined that nearly half of the cases at a tertiary children's referral center could have been avoided by first contacting a poison center [9].

In 2022, The New Jersey Poison Information and Education System (NJPIES) received 1,436 calls from New Jersey ED medical providers for patients less than six years of age, who presented to the ED with a potentially poisonous exposure. This study aims to demonstrate that many pediatric ED presentations for suspected poisoning do not require emergency evaluation, by having a panel of toxicologists evaluate cases and assess their ED need. It is hypothesized that many of these cases will be determined to not be medically necessary, and further exploration of specific factors that cause increased concern by toxicologists will be explored.

Methods

This was a mixed-methods retrospective analysis of existing medical records as documented in the Toxicall® electronic database. All data extracted was free of personally identifiable information, and this study was approved by the Institutional Review Board of Rutgers New Jersey Medical School as exempt (Study Approval: Pro202300085). It was acknowledged that pediatric patients are a protected research group; however, this study posed no risk to patients as all cases were closed and deidentified.

Study data

In this retrospective analysis, NJPIES Toxicall® electronic database was queried. Cases reviewed presented between January 1, 2022, and December 31, 2022, and were identified and filtered using the following criteria: age less than six years, call from a healthcare facility, and “unintentional” exposure only. Variables extracted included age, gender, time and day, route, substance(s) exposed, reported symptoms, certainty of exposure, and exposure location. Additionally, the narrative section as documented by the Specialists in Poison Information (SPI) was abstracted and refined to create a history of present illness of the poisoning event.

The primary outcome of the study was to evaluate the proportion of pediatric ED presentations that were not medically necessary, according to a group of reviewing toxicologists. In the 1983 seminal study [8], 63% of ED visits were deemed unnecessary. Based on these data, we determined that a sample size of 348 cases would be required to estimate the proportion of medically unnecessary visits with 95% CI and a 5% margin of error [8].

Case review

Cases were reviewed by four medical toxicologists (physicians) and one clinical toxicologist (pharmacist) at the NJPIES. Cases were randomly assigned to each reviewer, and each case was reviewed twice. Case review took place on a standardized sheet, stored on a HIPAA compliant OneDrive. Cases were reviewed and rated on the likelihood that the toxicologist believed that the patient required emergency department evaluation. Each reviewer assigned a “disposition selection” based on a four-point Likert scale with the following categories: (1) Definitely would not send to the ED; (2) Likely would not send to the ED, need more information; (3) Likely would send to the ED, need more information; and (4) Definitely would send to the ED.

Toxicologists were only provided with the child's age, time of day, day of week, substance name, and HPI that was based on SPI free text. The study team systematically edited the "HPI" to only include information regarding the initial presentation to the ED, which could have otherwise been relayed to a poison center by a parent over the phone. History of present illnesses was standardized to be 2–3 sentences long and did not include ED-obtained vitals, diagnostics or advanced physical exam findings.

Data analysis

The percentage of each disposition was calculated, in addition to an extrapolated "Yes/No" binary score. This manipulation was conducted utilizing computing software to change the "1" and "2" (i.e., Definitely would not send to the ED and Likely would not send to the ED, need more information) Likert scores to a combined "0" (No, would not send to the ED.) Then, combining the "3" and "4" (i.e., Likely would send to the ED, need more information, and definitely would send to the ED) Likert scores to a combined "1" (Yes, would send to the ED.) This manipulation was done to represent the need to make a decision- yes or no, in regard to if a parent should bring the patient to the ED.

In addition to raw percentages, a concordance rate was calculated for both the four-point and the binary extrapolation to assess agreement.

Binomial logistic regression

A binomial logistic regression was calculated to understand case factors that impacted reviewer disposition. To complete this, the extrapolated "Yes/No" data was used to find cases where reviewers agreed on either sending the patient to the ED (1) or having them remain at home (0). Cases where reviewers did not agree ($n=83$) were removed from this analysis as there was not a unanimous agreement amongst the two reviews. To complete this, data was extracted from Toxicall® and converted to a workable code using find and replace functions (See [Supplementary Appendix 2](#)). In addition to the standardized information given to toxicologists, other coded information (clinical symptoms, route of ingestion, certainty, substance category) were included in the regression as they were described in the narrative section.

Spearman's rho correlation analysis

To explore if a relationship between years of practice and reviewer disposition decision exists, a Spearman's

Rho association was completed. Number of years since graduation from toxicology fellowship (for physicians) or years since starting to work at a poison center (for clinical pharmacists) was compared to disposition based on four-point Likert scale.

Content analysis

Reviewers had the optional opportunity to enter free text for each case to share what additional information would be beneficial for their triage disposition. This data was then evaluated by study team members for thematic grouping looking for patterns amongst reviewers using Tagguate.org [10]. To do this, free text data from the data collection sheets were merged into a collated document, where reviewers then analyzed the text for apparent themes that were mentioned several times. Repeat analysis took place to confirm accurate tagging and the final tabular results was created as a frequency table.

Results

To achieve the predetermined sample size, a query of the NJPIES Toxicall® Data base resulted 1,436 cases that met criteria. From these cases, a random number generator was utilized to select cases for analysis. During review, 124 cases did not meet the study criteria as outlined in [Figure 1](#). At the end of case review, a total of 472 of the 1,436 cases were reviewed, with 124 excluded and 348 ultimately selected for analysis.

Toxicologists designated 26% of patients as "definitely" requiring ED evaluation and 9% as "likely" in need of ED care, but more information required. Conversely, approximately 65% of patients were categorized as not requiring emergency evaluation, with 38% assigned as definitely not needing emergency care and 27% likely not requiring care. [Table 1](#) demonstrates the breakdown between reviewer disposition for both the 4-point Likert scale, in addition to the extrapolated binary yes/no.

Additionally, the reviewer's concordance was evaluated. When reviewing Likert scale-based dispositions, reviewers agreed approximately 48% of the time and when extrapolated to a binary yes/no, this increased to 76% of the time ([Table 2](#)).

Binomial logistic regression

Binomial logistic regression showed that the presence of clinical effects was the only significant case factor that influenced a toxicologist to refer a patient to the

* See Appendix 1 for full details of exclusion criteria.

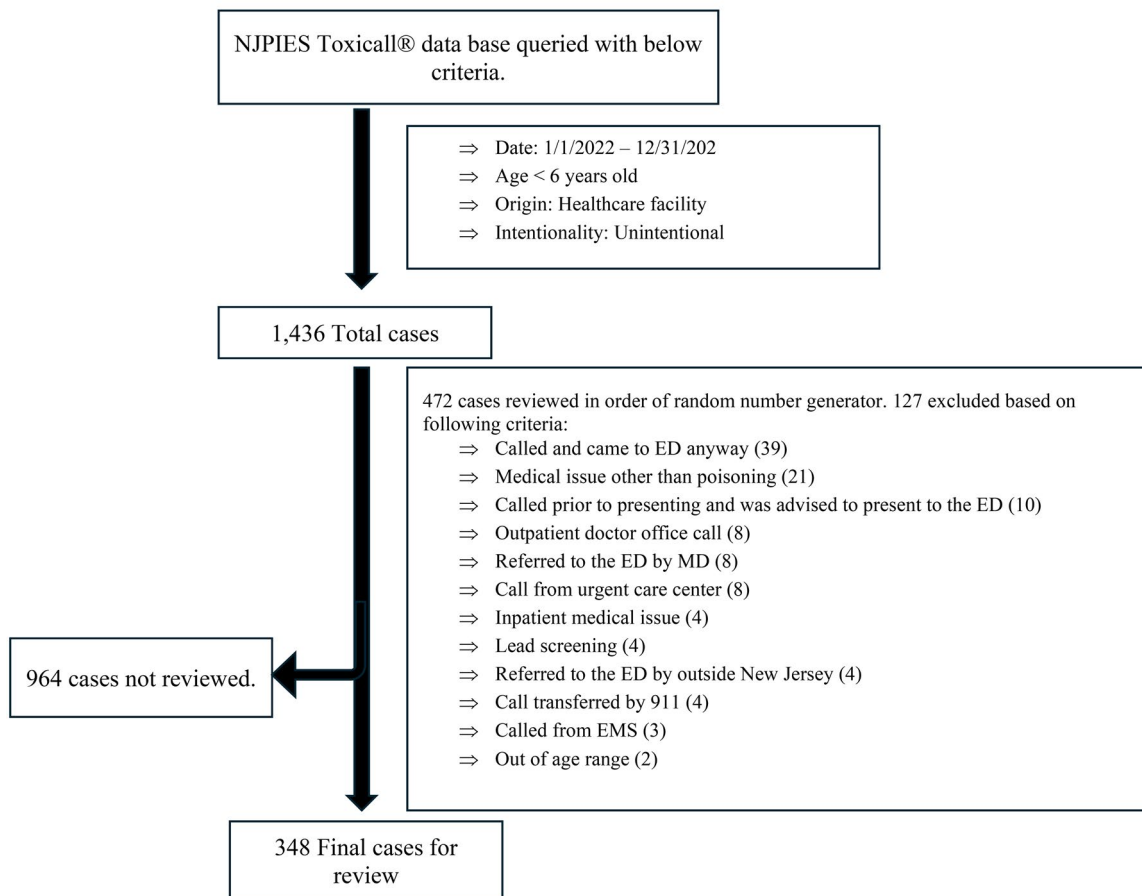


Figure 1. Case selection diagram.

*See [Supplementary Appendix 1](#) for full details of exclusion criteria

Table 1. Reviewer disposition based on 4-point Likert scale and extrapolated binary score.

	Reviewer 1 (n)	Reviewer 2 (n)	Mean (n)	Mean (%)
Four-Point Likert Score				
Definitely would not send to the ED (1)	124	140	132	38%
Likely would not send to the ED, need more information (2)	101	87	94	27%
Likely would send to the ED, need more information (3)	35	25	30	9%
Definitely would send to the ED (4)	88	96	92	26%
Binary score (extrapolated)				
No, would not send to the ED (0)	225	227	226	65%
Yes, would send to the ED (1)	123	121	122	35%

ED with results seen in [Table 3](#). Statistical significance was not seen in relation to the time of day, age, gender, substance category or any other category.

Table 2. Concordance rates for 4-point Likert scale and binary Yes/No.

	4-point Likert scale		Binary yes/ No	
	n	%	n	%
Agreement				
Concordant	167	48%	264	76%
Non-concordant	181	52%	84	24%

Spearman's rho correlation

Spearman's rho correlation analysis was completed to understand the relationship between years of toxicology experience and disposition decision based on the four-point Likert scale. Analysis found a $SR = -0.11$ ($P = 0.004$), indicating a weak, yet statistically significant negative association between increased years of experience and perceived need for emergency evaluation.

Qualitative data. [Table 4](#) displays the qualitative data based on reviewer free response. Reviewers frequently requested more information regarding the story of the actual exposure (e.g., medical history of the child, time since exposure, how the child was feeling prior to being exposed, etc.) in addition to any specific

Table 3. Binomial logistic regression for factors impacting reviewer disposition amongst cases with unanimous yes/no agreement.

Category	B*	Standard error	Wald**	Degrees of freedom	Significance
Day of week	-0.172	0.399	0.186	1	0.666
Time of day			2.210	2	0.331
Certainty of exposure			2.760	2	0.252
Substance category			28.632	20	0.095
Age	0.039	0.188	0.042	1	0.837
Gender of patient	-0.563	0.371	2.301	1	0.129
Location of exposure			1.064	3	0.786
Route of exposure			4.084	6	0.665
Clinical effects present	2.261	0.433	27.311	1	<0.001
Constant	-3.247	1.276	6.478	1	0.011

*B represents the estimated log odds for the predictor variable.

**Wald is the χ^2 test statistic for the coefficient (log odds).

Note: B value and standard error values that are blank are variables that included two or more categories. Individual category values not included as they were not statistically significant.

Table 4. Thematic data related to desired additional information during case Review.

Theme	n
Requesting more details about events surrounding potential exposure	26
Need more information regarding specific symptoms	25
Would want to observe at home then come in if clinical change	23
Need more information regarding ingredients	17
Follow-up via SPI telephone check-in would be beneficial	13
Call represents a need for evaluation regarding a medical condition not-specifically related to poisoning	9
MSDS requested	9
Requesting information regarding patients' weight	8
Uncertainty related to the substance reported	1

MSDS: material safety data sheet

symptoms (e.g., fever, fatigue, vomiting, irritability, etc.) that the patients were having at the time of contact. Toxicologists also sought information about the substances involved including the MSDS, ingredients, and improved clarity on patients' weight. Many times, toxicologist also shared that they would prefer the patient to undergo an at home observation period with SPI follow up rather than immediately presenting to the emergency department.

Discussion

Toxicologists identified that many pediatric self-referrals to the ED, after presumed poison exposure did not require ED evaluation. Additionally, binomial regression identified the presence of clinical symptoms as a significant case factor that impacted toxicologist's concern and thus, changed the likelihood of requiring emergency medical treatment.

About 65% of ED visits were deemed to not have required emergency department evaluation. This number suggests that many patients and families could have avoided the ED, saving time, improving resource utilization, and decreasing healthcare spending. Reviewer concordance rates, as seen in Table 4, indicate high levels of agreement amongst toxicologists, only when extrapolated to a yes/no in terms of likelihood of referring to the ED. This suggests that if asked to make a yes/no decision regarding if the ED evaluation was required, reviewers agreed approximately 75% of the time. When offered a 4-point option, however, reviewers could not agree on the need for Emergency Department evaluation. This is likely due to ambiguity involved with the intermediate answers (likely yes or likely no, need more information) which both allow for a wide degree of interpretation. Future research should continue to ask toxicologists on a four-point scale but also request for toxicologists to make an ultimate binary decision.

A Spearman's Rho correlation analysis demonstrated a weak, but significant linear relationship between years of toxicology experience and the likelihood of requiring emergency department evaluation (SR=-0.11, $P=0.004$). This value indicates that with more experience, toxicologists were slightly less likely to decide that ED care was needed. This was seen with the significant, but weak negative relationship, that likely played little effect as the SR was near 0. Thus, since length of practice did not likely explain the discrepancy that was seen amongst reviewers, qualitative data may help to explain this variation.

Toxicologists requested additional information regarding specific symptoms ($n=25$) and a better understanding of the story surrounding the exposure ($n=26$) to make the best assessment of need for ED evaluation. These two categories relate well to the binomial logistic regression findings that clinical symptoms are a significant factor impacting toxicologist level of concern. Additionally, Toxicologists also suggested home observation, with follow-up calls at determined time-intervals to monitor patients and re-triage as necessary. Home observation was mentioned by toxicologists several times ($n=23$), in addition to suggesting SPI check in with the patient at a later time ($n=13$). The goal of home observation is to minimize resource usage initially, while still allowing for ED escalation, should the condition deteriorate. While follow-up calls can be time consuming for SPIs, this strategy can decrease the burden on EDs and provide the opportunity for PCCs to better obtain information regarding the poison exposure. Additional options to improve understanding of patient

conditions remotely include a text chatting feature that is already being utilized at PCCs, in addition to incorporating video chat capabilities to assist clinicians and SPIs in understanding patient presentations when reports by callers are unclear.

Comparing these findings to the seminal 1983 study, which found that 63% of pediatric poisoning cases seen in EDs were not necessary, this study observed a remarkably similar rate (65%) of cases that likely did not require ED presentation. This consistency over decades highlights the ongoing issue that poison centers are not being utilized to their full potential, and further efforts should be made to increase public awareness of poison centers and their ability to provide critical information, cost savings and time savings to families.

Future studies

Future studies should have specialists in poison information (SPI) similarly evaluate cases of pediatric poisoning that were brought to the ED without first calling a PCC. This would improve the understanding of the capability of PCCs to prevent unneeded ED visits that were identified in this study. This study also identified that clinical symptoms are key indicators of toxicologist concern when deciding on a patient's need for emergency evaluation. Thus, further work should improve methods of remotely assessing symptoms in children, in addition to improving training for obtaining key data required to make such critical disposition decisions.

Limitations

There are several limitations to our study. As the data reviewed is retrospective, it is reflective of decisions already made with information not available to the reviewers. There is always the possibility of miscoding error in the Toxicall® database, and thus the exact number of cases that met criteria can be erroneous. The decision to triage to the ER is made by Certified Specialists in Poison Information (CSPIs) and their interactions in real time, with active patients, may color and impact disposition decisions. Future analysis should include a cadre of CSPIs to improve the ecological validity of the study. In this study toxicologists were asked to rank their disposition on a four-point Likert scale, rather being asked to directly answer “yes or no” to requiring ED evaluation. While the binary extrapolation completed in this study hopes to understand the overall need for ED, there is a possibility of misinterpretation of the four-point conversion to a

binary. Thus, the results of the binary conversion should be taken with consideration, because of this post hoc manipulation. Finally, this study was completed at one PCC where provider decision making might be influenced by group policies and community practices. In the future, involving more PCCs in a similar study could improve the generalizability of the findings.

Conclusions

This study found that many cases (65%) of children less than six years old who presented to the ED without calling a poison center did not require ED evaluation when reviewed by toxicologists at a single PCC. Additionally, toxicologists identified the presence of clinical symptoms as a main indicator leading to increased concern for ED evaluation, showcasing similar findings to prior studies.

Ethics statement

All the data reported in this manuscript were ethically obtained after IRB approval.

Disclosure statement

No potential conflict of interest was reported by the authors.

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