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Systematic Review

Clinical predictors of severe outcomes in adult and pediatric poisoning patients presenting to emergency departments: a systematic review

Mazi Mohammed Alanazi[1], Ghidah Zouhair Altabsh[2], Osama Sameer Almaghrabi[3]

1. Saudi and Jordanian Board Emergency Medicine, Emergency Department, Head of Emergency Research Unit, First Health Cluster, Riyadh, Saudi Arabia
2. Saudi Board Emergency Medicine Resident Program, Emergency Medicine Department, East Jeddah Hospital, Jeddah, Saudi Arabia
3. Saudi Board Pediatric Resident, pediatric Department, King Abdulaziz University Hospital, Jeddah, Saudi Arabia

Abstract

Background: Poisoning is a common emergency department presentation and range from mild exposure to life-threatening intoxication. Early identification of patients at high risk for severe outcomes is important because some of the patients look stable at first and then deteriorate later. In this study we aimed to identify clinical predictors associated with severe outcomes in adult and pediatric poisoning patients presenting to emergency departments. **Methods:** This systematic review included original studies evaluated predictors of severe outcomes in acute poisoning patients. We conduct the literature search in PubMed, Web of Science, Scopus, and Embase from database inception until 2025. Screening was done in two stages, including title and abstract review followed by full-text assessment. Data extracted on study design, population, poisoning type, predictors, severe outcomes, and main findings. **Results:** A total of 10 studies were included. The studies involved adult, pediatric, and mixed-age populations with different poisoning types, including acute drug overdose, salicylate poisoning, amitriptyline poisoning, diphenhydramine toxicity, and general acute poisoning. Severe outcomes included mortality, intensive care unit admission, intubation, and adverse cardiovascular events. Predictors include clinical findings, lactate, electrocardiographic abnormalities, age-related factors, inflammatory biomarkers, and clinical prediction models. **Conclusion:** Severe outcomes in poisoning predicted by a combination of clinical, laboratory, ECG, and age-related factors rather than one single predictor.

Keywords: Poisoning; Acute intoxication; Emergency department; Clinical predictors; Severe outcomes

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Introduction

Poisoning in the emergency department (ED) include a wide spectrum, from asymptomatic exposure to life-threatening intoxication, and the severity of poisoning depends on specifics related to the toxin and the timing of ingestion in relation to the availability of medical treatment. The early bedside problem is diagnostic and therapeutic as the manifestations are protean, the history incomplete, and recognition of a specific toxidrome help, but many clinical manifestations are masked by coexisting conditions [1]. Diagnostic uncertainty is not trivial, because patients are sickest in the first few hours of illness, poisoning-related ED visits have been increasing, and emergency physicians are required to make rapid decisions about resuscitation, airway control, extracorporeal toxin removal, and disposition while adverse sequelae are still evolving. The early phase includes seizures, hypoxia, hypercapnia, rhabdomyolysis, metabolic acidosis, elevated lactate, acute respiratory distress syndrome, cardiogenic shock, acute liver failure, or multiple organ failure. These features make prognostic stratification central to emergency toxicology rather than secondary to it [1–3].

A toxidrome is a constellation of findings from the physical examination or ancillary testing that narrow the differential diagnosis and guide management, yet many toxidromes have overlapping features and modified by comorbid conditions, or coingestants. Toxicology screening limited value in the emergency management of most poisoned patients, because supportive care is usually directed at mental status, cardiovascular function, and respiratory condition rather than at a screening result [3,4]. In salicylate poisoning, serum salicylate levels alone are not adequate to assess seriously poisoned patients, and half of the patients who died arrived at the ED alert and deteriorated there, and 39% of patients with severe salicylate poisoning requiring ICU management arrived alert with minimal clinical manifestations. This dissociation between initial appearance and subsequent physiological decompensation is the setting in which clinically useful predictors are needed [3,4].

Pediatric poison exposures commonly occur in children 1 to 5 years of age and are exploratory in nature, but incidence and morbidity increasing, and certain substances are more dangerous to young children than adult experience because of inherent differences in physiology and pharmacokinetics. More than 1.2 million exposures per year in children younger than 6 years were reported during 2009 to 2011, more than 2500 developed life-threatening illness, and 109 died of exposure-related effects over that period [1,5,6]. Adult poisoning encompasses intentional overdose, substance misuse, occupational and accidental exposure, therapeutic misadventure, and drug interactions, each with distinct pathophysiology and different implications for the same bedside finding. A diminished Glasgow Coma Scale score, does not carry a prognosis in toxic exposures, and the significance of lethargy, nausea, vomiting, or altered mental status changes according to the poison involved. These age-related and exposure-specific differences argue against a single simplistic severity framework and favor clinically grounded predictor synthesis in poisoned populations presenting to EDs [1,5,6]. In paracetamol poisoning, more accurate risk predictors are sought specifically to identify

hepatotoxicity before it is biochemically apparent, because established liver failure criteria are useful only once the patient is critically unwell. The toxicology literature supports the need for a focused synthesis of clinical predictors associated with severe outcomes and physiological decompensation in adult and pediatric poisoning patients presenting to EDs [6,7].

Methods

This systematic review was done to identify clinical predictors of severe outcomes in adult and pediatric patients presenting to the ED with acute poisoning. The review included original studies that assessed clinical findings, laboratory results, electrocardiographic findings, and clinical prediction tools association with poor outcomes in poisoned patients. The outcomes reported in the included studies were not the same, but mainly included mortality, ICU admission, intubation, adverse cardiovascular events, and other indicators of severe poisoning

The literature search was carried out in PubMed, Web of Science, Scopus, and Embase from database inception until 2025. In the search we used keywords and related terms for poisoning, intoxication, overdose, ED, predictors, prognostic factors, severity, mortality, and intensive care. All studies identified from the databases were collected in Mendeley, and duplicate studies were removed before screening.

Screening was done in two steps; first, titles and abstracts were reviewed to exclude irrelevant studies; then, full texts of the remaining articles assessed for eligibility. We include original human studies involved adult, pediatric, or mixed populations with acute poisoning presenting to ED or acute care settings. The included studies assessed one or more predictors of severe clinical outcomes. We exclude reviews, editorials, letters, conference abstracts without enough usable data, animal studies, or studies not related to predictors of severe outcomes in poisoning patients.

Data were extracted using a standardized data extraction sheet, and extracted items included study citation, design, setting and country, population, sample size, poisoning agent, severe outcome definition, predictors assessed, and main findings. The included studies varied in study design, populations, poisoning agents, and outcomes, with studies including adults, pediatric, and mixed-age populations and different poisoning types such as acute drug overdose, salicylate poisoning, diphenhydramine toxicity, amitriptyline poisoning, and general acute poisoning.

Results

We included 10 studies in this systematic review [8–17]. Most of the included studies were prospective cohort studies [8–10,15,16], one study was a prospective validation cohort study [9], one was a prospective observational study [14], and the remaining studies were a retrospective analysis, evaluation study, and a prediction model study [11–13]. The studies were conducted in the United States [8–10,16,17], Turkey [11], South Korea [12] Netherlands [13] and Romania [14,15]. Adult populations were included in several studies [8,9,15,17], one study included a pediatric population younger than 18 years [10], one study included an all-age cohort [12]. The poisoning types include overdose [8,17], acute salicylate poisoning [9], Amitriptyline poisoning [11], Diphenhydramine toxicity [16], acute poisoning [12,14], General

intoxication [13], acute drug exposures in pediatric patients [10] and nonpharmaceutical agents [15].

Regarding study size Han et al.[12] include 42,568 patients, Manini et al. 1,562 patients, and Manini et al. 2017 589 patients. Other studies included smaller cohorts, such as Paksu et al.[11] with 250 patients and Lionte et al.[15] with 315 patients. The included studies represented broad poisoning populations and more specific toxic exposures, which provide a view of severe outcomes predictors in ED poisoning cases.

Regarding the severe outcomes assessed in the included studies, some studies focused on mortality, while others evaluated ICU admission, intubation, or adverse cardiovascular events (ACVE) such as myocardial injury, shock, ventricular dysrhythmia, or cardiac arrest. One study reported that ACVE occurred in 82 patients (5.2%) [17], another study on salicylate poisoning found that lactate was a significant predictor of severe outcome (p=0.002), and coma was also associated with increased risk with an odds ratio of 7.7 (p=0.05) [9]. In the pediatric study, younger age groups had lower risk for ACVE compared with teenagers, with odds ratios of 0.41 in children younger than 2 years and 0.37 in children aged 2 to 6 years [10].

Han et al. developed the new-Poisoning Mortality Score (new-PMS) for prediction of in-hospital mortality. Brandenburg et al. developed a model to identify patients requiring ICU-level care. Lionte et al. [14] reported that inflammatory biomarkers and inflammation-related indices (NLR and PLR) were predictive for ICU hospitalization and mortality. Another study validated initial ECG features as prognostic indicators for ACVE, while Lionte et al. [15]developed and validated a nomogram for adult poisoning mortality. We found that severe outcomes in poisoning predicted by a combination of clinical findings, laboratory variables, ECG features, age-related factors, and prediction models.

Table 1: characteristics of included studies

Study	Study design	Setting and country	Population	sample size	Poisoning agent
Manini 2015 [8]	Prospective cohort	Two urban university hospitals, New York, US	Adults (Mean 41.8 years)	1562	Acute drug overdose
Shively 2017 [9]	Prospective cohort	New York, US	Adults (Mean 41.2 years)	60	Acute Salicylate Poisoning
Carreiro 2020 [10]	Prospective cohort	US (ToxIC database)	Pediatric (<18 years)	13097	Acute drug exposures
Paksu 2014 [11]	Evaluation study	University hospital, Turkey	Adults	250	Amitriptyline
Han 2021 [12]	Retrospective analysis	South Korea (KCDC cohort)	All ages	42568	Acute poisoning

Study	Study design	Setting and country	Population	sample size	Poisoning agent
Brandenburg 2016 [13]	Prediction model study	Netherlands	Intoxicated patients	10123	General intoxication
Lionte 2021 [14]	Prospective observational study	Tertiary referral center, Romania	Adults	1548	Acute poisoning
Hughes 2021 [16]	Prospective cohort	US (ToxIC database)	Adults	863	Diphenhydramine
Manini 2017 [17]	Prospective validation cohort study	Two urban university hospitals, US	Adults (Mean 42 years)	589	Acute drug overdose
Lionte 2017 [15]	Prospective cohort study	Tertiary referral center, Romania	Adults (18–91 years)	315	Drugs and nonpharmaceutical agents

Table 2: clinical predictors and severe outcomes

Study	Severe outcomes defined	Predictors evaluated	Key findings and statistical results
Manini 2015 [8]	In-hospital Adverse Cardiovascular Events (ACVE): myocardial injury, shock, ventricular dysrhythmia, or cardiac arrest	Independent clinical risk factors (GCS, acidosis)	ACVE occurred in 82 patients (5.2%).
Shively 2017 [9]	Severe outcome (ICU admission, intubation, death)	Age, respiratory rate, creatinine, lactate, anion gap, salicylate serum concentration, coma	Lactate was a significant predictor (p=0.002); Coma had an Odds Ratio (OR) of 7.7 (p=0.05).
Carreiro 2020 [10]	In-hospital ACVE and death	Age category, sex, race	Younger age categories had lower risk for ACVE compared to teens: <2 years (OR 0.41), 2–6 years (OR 0.37).
Paksu 2014 [11]	Outcomes related to amitriptyline overdose	Clinical prediction model variables	250 patients evaluated for toxicity patterns.
Han 2021 [12]	In-hospital mortality	new-PMS score components (poisoning characteristics and physiological conditions)	Developed the new-Poisoning Mortality Score (new-PMS) to predict mortality for all ages.
Brandenburg 2016 [13]	Need for ICU admission	Clinical prediction model variables	Developed a model to identify patients requiring ICU-level care.

Study	Severe outcomes defined	Predictors evaluated	Key findings and statistical results
Lionte 2021 [14]	Risk of ICU hospitalization and mortality	Biomarkers of inflammation and inflammation-related indexes (NLR, PLR)	Admission biomarkers and indexes are predictive for ICU risk and mortality.
Hughes 2021 [16]	Severe outcome in diphenhydramine toxicity	Clinical and patient characteristics	Specific characteristics are associated with severe clinical courses.
Manini 2017 [17]	ACVE (circulatory shock, myocardial injury, ventricular dysrhythmia, or cardiac arrest)	ECG features: ectopy, QT prolongation, nonsinus rhythm, ischemia, QT dispersion, R wave in lead AVR	Validated initial ECG features as effective prognostic indicators for ACVE.
Lionte 2017 [15]	In-hospital mortality	Clinical and paraclinical manifestations	Created and validated a risk-prediction nomogram for adult poisoning mortality.

Discussion

The present review showed that severe outcomes in poisoned patients were related to a group of predictors together, including clinical findings, laboratory abnormalities, ECG changes, age-related factors, and prediction models [15,17]. Poisoning cases in the ED are difficult at the start, the history sometimes incomplete, and patients may worsen in the first hours while the team is still trying to identify the toxin and assess organ involvement [1,2]. Toxidrome recognition is useful, but not enough because many toxidromes overlap and some clinical pictures changes by co-ingestion, comorbidity, or delayed toxicity [3].

Another important finding in this review was the salicylate study, where lactate was a significant predictor of severe outcome and coma was also linked with increased risk, so metabolic stress and neurologic deterioration are important warning signs in these patients [9]. According to literature, serum salicylate level alone is not enough to judge severity, and serial salicylate levels with blood gas analysis are needed because patients may look mildly ill at the beginning and deteriorate later [4]. The same article showed that some cases of severe salicylate-poisoning arrived alert with minimal manifestations, so repeated reassessment is very important in the ED [4].

The pediatric findings in the present study were important because younger children had lower odds of adverse cardiovascular outcomes than adolescents, while QTc prolongation and low bicarbonate were linked with higher ACVE risk, which means age and early objective tests still matter in children as well [10]. Adolescent exposures are more intentional and severe, because opioid and cardiovascular drug exposures can cause major cardiorespiratory compromise even in previously healthy children [10].

These results agree with pediatric toxicology principles that poisoned children have limited physiologic reserve and pass quickly from relative stability to serious airway, respiratory, or circulatory problems, so early ECG and close monitoring are important [5]. The importance of ECG findings in our review supported by general toxicology literature showing that sodium channel blockade and potassium channel blockade produce QRS or QTc abnormalities that reflect real risk of ventricular dysrhythmia and hemodynamic instability [3,5].

The present review found that prediction models is useful, and this was clearly seen in the adult nomogram study where age, lactate, potassium, CKMB, QTc interval, and diastolic function variables were used to estimate in-hospital mortality with good performance [15]. The results should not be taken as standard that one universal score works for all poisonings, because the Poisoning Severity Score was described as a severity description tool and not a prognostic tool, and later reviews showed that it was modified or misapplied and not ideal for all toxic exposures [6].

A similar issue is seen in paracetamol poisoning, where reported dose, concentration, PT, aminotransferases, half-life, and other tools help risk prediction, but each one has limitations and should be interpreted in the full clinical context instead of alone [7]. We found that the best way to assess poisoned patients is by combining clinical examination, serial reassessment, ECG findings, laboratory markers, and poison-specific knowledge, because dependence on one test can miss patients who will deteriorate later.

Conclusion

The present study showed that severe outcomes in poisoned patients predicted by a combination of clinical findings, laboratory abnormalities, ECG changes, age-related factors, and clinical prediction tools. Important outcomes were mortality, ICU admission, intubation, and adverse cardiovascular events. Poisoned patients in the ED need early careful and repeated assessment, even when the first presentation is mild. Identifying high-risk patients early help improve monitoring, disposition, and treatment decisions.

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