Predictors of Severity and Clinical Outcomes in Acute Pediatric Cannabis Intoxication: A Narrative Review

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Abstract

Background: Acute pediatric cannabis intoxication has emerged as an increasingly important public health and toxicological concern following the expanding legalization of medical and recreational cannabis and the widespread availability of high-potency cannabis products, particularly edible formulations. Young children are especially vulnerable because of exploratory behavior, lower body mass, immature metabolic pathways, and increased susceptibility to the central nervous system effects of Δ9-tetrahydrocannabinol (THC). Although most pediatric exposures result in complete recovery with supportive care, an increasing number of children present with severe neurological and cardiorespiratory complications requiring intensive care. Despite the growing incidence of pediatric cannabis poisoning, reliable predictors of disease severity and clinical outcomes remain incompletely characterized, creating challenges in early risk stratification, emergency management, and resource utilization. This narrative review aims to comprehensively evaluate the current evidence regarding clinical, laboratory, and toxicological predictors of severity and clinical outcomes in acute pediatric cannabis intoxication. Particular emphasis is placed on demographic characteristics, route of exposure, estimated THC dose, neurological and cardiovascular manifestations, laboratory abnormalities, toxicological investigations, and other prognostic indicators associated with intensive care admission, prolonged hospitalization, respiratory support, and adverse clinical outcomes. The review also discusses the underlying pathophysiological mechanisms, diagnostic challenges, and current management strategies from the perspective of forensic medicine and clinical toxicology while identifying existing knowledge gaps and future research priorities.

Conclusion: Current evidence indicates that younger age, ingestion of high-potency edible cannabis products, larger estimated THC dose, depressed level of consciousness, respiratory depression, seizures, cardiovascular instability, metabolic abnormalities, and delayed presentation are among the most important predictors of severe pediatric cannabis intoxication. However, no single clinical or laboratory parameter accurately predicts disease progression, highlighting the need for comprehensive clinical assessment integrating patient history, physical examination, toxicological evaluation, and continuous monitoring. Standardized prognostic models specifically designed for pediatric cannabis poisoning are currently lacking and represent an important unmet clinical need. Future multicenter prospective studies are essential to validate reliable prognostic biomarkers and develop evidence-based risk stratification tools that improve early recognition, optimize clinical management, and enhance outcomes in children with acute cannabis intoxication.

Keywords: Outcomes, Acute Pediatric. Cannabis Intoxication

Introduction

Acute pediatric cannabis intoxication has become an increasingly important concern in pediatric emergency medicine and clinical toxicology, particularly with the wider availability of cannabis products and the increasing commercialization of edible preparations. Young children are at special risk because exposures are usually accidental and occur in the home environment, where cannabis-containing products may be stored within reach and may resemble ordinary sweets, chocolates, or baked goods. These characteristics increase the likelihood of unintentional ingestion and delayed caregiver recognition, making pediatric cannabis intoxication a growing toxicological problem requiring careful clinical evaluation and early risk assessment. **[1]**

Children are more vulnerable than adults to the toxic effects of Δ9-tetrahydrocannabinol because of their lower body weight, developmental physiology, and greater sensitivity of the central nervous system. Following ingestion, the absorbed dose per kilogram may be relatively high, especially when the child consumes concentrated edible products. Oral exposure is particularly important because gastrointestinal absorption is delayed and first-pass hepatic metabolism produces active metabolites that may prolong neurological depression. These pharmacokinetic features explain why pediatric cannabis intoxication may present later than expected and may persist for several hours after exposure. **[2]**

The clinical manifestations of acute pediatric cannabis intoxication vary from mild drowsiness and behavioral changes to severe neurological and cardiorespiratory depression. Lethargy, hypotonia, ataxia, vomiting, tachycardia, bradycardia, respiratory depression, seizures, and coma have all been described in affected children. Although most cases resolve with supportive care, severe intoxication may require oxygen therapy, airway protection, mechanical ventilation, intensive care admission, or prolonged observation. Therefore, the initial clinical presentation should not be considered merely diagnostic but also potentially prognostic. **[3]**

Prediction of severity is essential because not all children with cannabis exposure require the same level of care. Some patients can be safely observed until clinical recovery, whereas others may deteriorate and require pediatric intensive care. Reported factors associated with severe toxicity include younger age, high estimated THC dose, edible ingestion, depressed level of consciousness, respiratory compromise, cardiovascular instability, seizures, delayed presentation, and suspected co-ingestion. However, the strength of association differs between studies, and no universally accepted pediatric prognostic model has yet been established. **[4]**

Laboratory and toxicological investigations may support diagnosis and risk stratification, especially when the history is unclear or inconsistent. Urine drug screening is commonly used to detect THC metabolites, but it does not reliably quantify dose, determine timing of exposure, or predict severity alone. Additional investigations such as serum glucose, blood gas analysis, lactate, electrolytes, and electrocardiography may be useful in children with coma, respiratory depression, seizures, hypotension, arrhythmia, or suspected polysubstance exposure. Thus, laboratory parameters should be interpreted as complementary tools rather than isolated predictors of outcome. **[5]**

From a forensic medicine and clinical toxicology perspective, pediatric cannabis intoxication requires attention not only to acute medical stabilization but also to exposure circumstances. Differentiating accidental ingestion from neglect, unsafe storage, recurrent exposure, or intentional administration is essential, particularly in infants and preschool children. Toxicological confirmation may also have medico-legal relevance when caregiver history is absent, delayed, or contradictory. These issues highlight the need for collaboration between emergency physicians, toxicologists, pediatricians, social workers, and child protection teams in selected cases. **[6]**

Despite the increasing number of studies describing pediatric cannabis exposure, most available literature focuses on epidemiology, clinical features, or general management. Fewer studies specifically evaluate which clinical and laboratory parameters predict severe outcomes such as intensive care

admission, respiratory failure, prolonged hospitalization, or need for advanced life support. This gap is clinically important because early identification of high-risk children may improve monitoring decisions, reduce complications, and guide hospital resource allocation. Therefore, this narrative review aims to evaluate the predictors of severity and clinical outcomes in acute pediatric cannabis intoxication, with emphasis on clinical, laboratory, toxicological, and forensic implications. **[7]**

Epidemiology of Acute Pediatric Cannabis Intoxication

Pediatric cannabis intoxication has increased noticeably in parallel with broader cannabis availability, especially where edible cannabis products are legally marketed. Young children represent the most vulnerable group because they commonly encounter cannabis products unintentionally within the home, often without caregiver awareness until symptoms develop. Edibles are particularly important epidemiologically because they are frequently prepared as candies, chocolates, cookies, or gummies, making them attractive and easily confused with ordinary food. This shift from traditional smoked cannabis to edible and concentrated products has changed the clinical landscape of pediatric poisoning by increasing the risk of higher-dose ingestion and more prolonged toxicity. **[8]**

The majority of reported pediatric cannabis intoxications occur in infants, toddlers, and preschool-aged children, usually below six years of age. This age distribution reflects developmental behavior, including curiosity, exploratory activity, and hand-to-mouth behavior, combined with limited ability to recognize danger. In this age group, exposure is usually accidental rather than intentional, and the home is the typical site of poisoning. These epidemiological features distinguish young children from adolescents, in whom cannabis exposure is more often related to experimentation, recreational use, or polysubstance ingestion. **[9]**

Legalization and commercial cannabis sales have been associated with increased pediatric hospitalizations for unintentional cannabis poisoning. Population-based data from Canada demonstrated that pediatric hospitalizations rose significantly after legalization, particularly after edible cannabis products became commercially available. This observation supports the toxicological concern that legalization alone may not be the only driver of pediatric risk; rather, product form, packaging, concentration, household storage, and caregiver awareness strongly influence exposure frequency and severity. **[10]**

Edible cannabis exposure is epidemiologically important not only because it increases the frequency of accidental ingestion but also because it may increase severity. Many edible products contain multiple THC servings in a single package, and young children may consume a large proportion of the product before an adult recognizes the exposure. Because oral THC has delayed onset, caregivers may initially underestimate the significance of ingestion, leading to delayed presentation and longer observation periods. Thus, edible exposure represents both an epidemiological and prognostic risk factor in acute pediatric cannabis intoxication. **[11]**

Poison center data show that pediatric cannabis exposures increased during recent years, with a marked rise in cases involving edible products. These data are important because they capture exposures beyond hospitalized cases and demonstrate the broader public health burden of accidental pediatric cannabis poisoning. However, poison center reports may underestimate true incidence because some exposures are managed at home, some are misdiagnosed as nonspecific altered mental status, and some caregivers may avoid disclosure because of legal or social concerns. Therefore, epidemiological estimates should be interpreted cautiously. **[12]**

From a forensic and clinical toxicology perspective, epidemiological evaluation should include not only age, route, and product type, but also the circumstances of exposure. Recurrent intoxication, inconsistent caregiver history, delayed medical presentation, unsafe storage, or exposure in infants should raise concern for possible neglect or inadequate supervision. These circumstances are relevant to child protection assessment and medico-legal documentation. Therefore, epidemiology in pediatric cannabis intoxication is not merely descriptive; it directly informs prevention, risk stratification, and forensic interpretation. **[13]**

Cannabis Products and Routes of Exposure Associated with Pediatric Intoxication

Cannabis products implicated in pediatric intoxication have evolved considerably over the past decade,

largely owing to the commercialization of high-potency formulations and expanding legal access in many countries. While traditional dried cannabis flowers remain a source of exposure, edible cannabis products have become the predominant cause of accidental poisoning in young children. Cannabis-infused chocolates, gummies, cookies, candies, and beverages are particularly hazardous because they closely resemble ordinary food products and are often packaged in ways that are attractive to children. Furthermore, many commercial products contain THC concentrations substantially higher than those found in traditional cannabis preparations, increasing the likelihood of severe intoxication following accidental ingestion. **[14]**

Edible cannabis products represent the most clinically significant formulation in pediatric toxicology because they combine delayed symptom onset with prolonged systemic toxicity. Unlike inhaled cannabis, orally ingested THC undergoes gastrointestinal absorption followed by extensive first-pass hepatic metabolism, producing the active metabolite 11-hydroxy-THC, which possesses potent psychoactive activity. Consequently, neurological manifestations may not appear for one to three hours after ingestion, often delaying caregiver recognition and medical evaluation. This delayed presentation also increases the probability of consuming larger quantities before intoxication becomes evident, thereby contributing to more severe clinical outcomes. **[15]**

Inhalational exposure is less common in young children but may occur through passive exposure to cannabis smoke or vapor within enclosed environments. Although passive inhalation generally produces lower systemic THC concentrations than oral ingestion, repeated or prolonged exposure may still result in clinically significant intoxication, particularly in infants because of their higher respiratory rates and lower body weight. Clinical manifestations following inhalational exposure are usually milder and shorter in duration; however, healthcare providers should consider this route when evaluating unexplained neurological depression in children living in households where cannabis is frequently smoked or vaporized. **[16]**

Cannabis concentrates, oils, tinctures, and vaping liquids have emerged as additional sources of pediatric exposure. These preparations often contain THC concentrations several-fold higher than conventional cannabis products and therefore may produce severe toxicity even after ingestion of relatively small volumes. Accidental exposure may occur when concentrated oils are stored in beverage containers or when vaping cartridges are left within reach of children. Because the exact cannabinoid concentration is frequently unknown, estimation of the ingested dose may be difficult, complicating early risk assessment and emphasizing the importance of careful clinical observation. **[17]**

Medical cannabis preparations prescribed for adults also represent an increasingly recognized source of accidental pediatric intoxication. Oral oils, capsules, and pharmaceutical cannabinoid formulations may be mistakenly administered to children or unintentionally ingested because of improper storage. Although these preparations are manufactured under standardized pharmaceutical conditions, they may still contain sufficient THC to produce clinically important toxicity in young children. Consequently, caregivers receiving medical cannabis should be educated regarding safe storage practices and appropriate child-resistant packaging to minimize accidental exposure. **[18]**

Synthetic cannabinoid receptor agonists should be differentiated from natural cannabis because their toxicological profile differs substantially. These synthetic compounds act as potent full agonists at cannabinoid receptors and have been associated with severe neurological, cardiovascular, and psychiatric complications that are considerably less common following natural cannabis exposure. Although synthetic cannabinoid intoxication remains relatively uncommon in young children, distinguishing these agents from traditional cannabis is important because they often require more aggressive supportive care and are not routinely detected by standard urine drug screening assays. **[19]**

Toxicokinetics and Pathophysiological Basis of Severity

The severity of pediatric cannabis intoxication is strongly influenced by the toxicokinetic behavior of Δ9-tetrahydrocannabinol, particularly its absorption, distribution, metabolism, and elimination. THC is highly lipophilic, allowing rapid penetration of biological membranes and extensive distribution into lipid-rich

tissues, including the brain. In children, lower body mass and developing neurological systems may increase susceptibility to central nervous system depression after relatively small exposures. These properties explain why clinical severity cannot be predicted by exposure history alone and must be interpreted in relation to route, formulation, dose, and patient-specific vulnerability. **[20]**

Oral ingestion is especially important because it produces delayed but prolonged toxicity. After ingestion, THC undergoes hepatic first-pass metabolism to 11-hydroxy-THC, an active metabolite with strong psychoactive effects. Peak clinical manifestations may therefore occur hours after exposure, which can mislead caregivers and clinicians during early assessment. This delayed progression is clinically relevant because a child who initially appears mildly symptomatic may subsequently develop marked lethargy, hypotonia, respiratory depression, or coma, supporting the need for prolonged observation after significant edible ingestion. **[21]**

The principal toxicodynamic effect of THC is mediated through partial agonism at cannabinoid CB1 receptors, which are widely expressed in the central nervous system. Excessive CB1 stimulation alters neurotransmitter release, including gamma-aminobutyric acid, glutamate, dopamine, norepinephrine, and serotonin, resulting in impaired consciousness, abnormal motor coordination, behavioral changes, and autonomic instability. In severe pediatric intoxication, this receptor-mediated depression may manifest as profound lethargy, hypotonia, coma, hypoventilation, or rarely seizures, making neurological status the most important bedside indicator of severity. **[22]**

Cardiorespiratory effects also contribute to severe outcomes in pediatric cannabis intoxication. THC exposure may produce tachycardia, bradycardia, hypotension, hypertension, and rarely dysrhythmic events, while central nervous system depression may impair respiratory drive and airway protective reflexes. These effects are particularly concerning in infants and toddlers because even transient hypoventilation or airway obstruction may rapidly cause hypoxia. Therefore, abnormal vital signs, oxygen desaturation, apnea, or the need for airway support should be considered high-risk prognostic markers requiring escalation of care. **[23]**

The pathophysiological basis of severe toxicity is also affected by product potency and co-exposure. High-concentration oils, extracts, and edibles may deliver a large THC dose in a small volume, while synthetic cannabinoid receptor agonists may cause more severe toxicity because many act as full agonists at cannabinoid receptors. In clinical practice, uncertainty regarding product composition, inaccurate labeling, and possible co-ingestion complicate prognostic assessment. For this reason, clinicians should treat unexplained severe manifestations, atypical cardiovascular findings, or prolonged coma as possible indicators of high-dose exposure or additional toxicants. **[24]**

Clinical Manifestations as Predictors of Severity

Neurological depression is the most important clinical predictor of severity in acute pediatric cannabis intoxication. Mild cases may present with sleepiness, dizziness, or behavioral change, whereas severe intoxication is suggested by profound lethargy, hypotonia, unresponsiveness, or coma. Because altered consciousness may progress after oral edible ingestion, the initial neurological examination should be repeated during observation. A low or deteriorating pediatric Glasgow Coma Scale score is therefore a practical bedside marker for identifying children who may require admission, airway protection, or intensive monitoring. **[25]**

Respiratory compromise is one of the strongest indicators of severe outcome. Children with hypoventilation, apnea, oxygen desaturation, cyanosis, or loss of airway protective reflexes are at increased risk of clinical deterioration and may require oxygen therapy, assisted ventilation, or endotracheal intubation. Respiratory depression usually reflects significant central nervous system cannabinoid effect and is more concerning in infants and toddlers because they have limited physiological reserve. Any child with cannabis exposure and respiratory instability should be managed as high risk until sustained recovery is documented. **[26]**

Cardiovascular abnormalities may also help stratify severity, although they are less specific than neurological and respiratory findings. Tachycardia is commonly reported and may occur even in moderate

intoxication, whereas bradycardia, hypotension, arrhythmia, poor perfusion, or need for intravenous fluid resuscitation suggest more severe toxicity. Electrocardiographic abnormalities are uncommon but clinically relevant, especially in adolescents or suspected co-ingestion. Persistent cardiovascular instability should prompt continuous monitoring, broader toxicological evaluation, and consideration of intensive care admission. **[27]**

Seizures are uncommon in natural cannabis intoxication but represent a serious warning sign when present. Their occurrence may indicate high-dose THC exposure, synthetic cannabinoid exposure, metabolic disturbance, hypoxia, trauma, infection, or co-ingestion with other neurotoxic substances. Therefore, seizures should not be automatically attributed to cannabis alone without appropriate evaluation. In the prognostic context, seizures identify a child at higher risk of complications, prolonged observation, neuroimaging consideration, and intensive care requirement. **[28]**

Gastrointestinal manifestations such as vomiting, nausea, and abdominal discomfort are more frequently associated with edible ingestion and may indirectly reflect oral exposure to a THC-containing product. Although vomiting alone is usually not a marker of severe intoxication, repeated vomiting may increase the risk of dehydration, aspiration, and delayed recovery, particularly in children with depressed consciousness. When gastrointestinal symptoms coexist with lethargy, hypotonia, or cardiorespiratory changes, they should support suspicion of significant edible ingestion and justify extended monitoring. **[29]**

Clinical severity should be assessed by integrating the pattern and progression of symptoms rather than relying on a single manifestation. The highest-risk presentations include coma, persistent depressed consciousness, respiratory depression, apnea, hypoxia, bradycardia, hypotension, seizures, or need for advanced supportive care. These features are more prognostically meaningful than a positive toxicology screen alone and should guide emergency triage, monitoring duration, admission decisions, and early consultation with pediatric intensive care or poison control services. **[30]**

Clinical and Laboratory Predictors of Severe Outcomes

Early identification of children at risk for severe cannabis intoxication is essential for appropriate triage and timely intervention. Several demographic and exposure-related variables have been associated with increased disease severity, among which younger age is one of the most consistently reported predictors. Infants and toddlers are more likely to develop significant neurological depression because of their lower body weight, immature hepatic metabolism, and greater THC exposure per kilogram. Furthermore, accidental ingestion in this age group is frequently unrecognized until symptoms become evident, contributing to delayed presentation and increasing the likelihood of hospitalization. **[31]**

The estimated THC dose and the type of cannabis product consumed are also major determinants of clinical severity. Recent evidence indicates that ingestion of approximately **≥1.7 mg/kg THC** is associated with a substantially increased risk of severe toxicity, prolonged neurological depression, and intensive care admission. High-potency edible products are particularly hazardous because they often contain multiple THC servings in a single package, making large-dose accidental ingestion common among young children. Consequently, whenever the ingested dose can be estimated, it should be incorporated into the initial risk assessment. **[32]**

Depressed level of consciousness remains the most reliable bedside predictor of adverse clinical outcome. Progressive lethargy, hypotonia, poor responsiveness, or coma are strongly associated with prolonged hospitalization and the need for intensive monitoring. In clinical practice, serial neurological examinations are more informative than a single assessment because deterioration may occur several hours after edible ingestion. Therefore, persistent or worsening neurological impairment should prompt escalation of care regardless of the initial toxicological results. **[33]**

Respiratory abnormalities are among the strongest predictors of critical illness. Children presenting with hypoventilation, apnea, oxygen desaturation, or the need for supplemental oxygen are at substantially greater risk of requiring endotracheal intubation and pediatric intensive care admission. Respiratory depression reflects severe central nervous system cannabinoid toxicity and should always be considered a

medical emergency. Early recognition of respiratory compromise allows prompt airway management and reduces the risk of secondary hypoxic brain injury. **[34]**

Cardiovascular instability also contributes to prognostic assessment. Although isolated tachycardia is relatively common and usually self-limited, persistent bradycardia, hypotension, arrhythmias, or impaired peripheral perfusion suggest more severe intoxication and warrant continuous cardiac monitoring. These abnormalities may be particularly important when accompanied by profound neurological depression or when co-ingestion of other cardioactive substances cannot be excluded. Accordingly, cardiovascular findings should be interpreted together with neurological and respiratory status rather than in isolation. **[35]**

Laboratory investigations provide valuable adjunctive prognostic information in selected patients with moderate or severe intoxication. Hypoglycemia, metabolic acidosis, and elevated serum lactate have been reported in children with severe neurological depression and coma, suggesting impaired tissue perfusion or prolonged hypoventilation. Although these abnormalities are nonspecific, their presence should alert clinicians to possible severe intoxication and justify closer observation, repeated clinical assessment, and consideration of intensive care support. **[36]**

Urine drug screening remains the most commonly performed toxicological investigation because of its high sensitivity for detecting THC metabolites. However, it has limited prognostic value, as a positive result confirms exposure but neither quantifies the ingested dose nor predicts disease severity or clinical outcome. Likewise, prolonged urinary excretion of THC metabolites prevents accurate estimation of exposure timing. Therefore, urine toxicology should be interpreted only as supportive diagnostic evidence and should never replace comprehensive clinical evaluation when determining prognosis. **[37]**

No single clinical or laboratory parameter independently predicts outcome in pediatric cannabis intoxication. Instead, prognosis should be based on an integrated assessment incorporating patient age, estimated THC dose, route of exposure, neurological status, respiratory function, cardiovascular stability, laboratory findings, and response during the observation period. Such a multidimensional approach provides the most reliable method for identifying children at risk for deterioration and supports appropriate decisions regarding admission, intensive care referral, and duration of monitoring. **[38]**

Management, Outcome Prediction, and Forensic Implications

Management of acute pediatric cannabis intoxication is primarily supportive and should be guided by predicted severity rather than toxicological screening alone. Initial care requires assessment of airway, breathing, circulation, neurological status, blood glucose, vital signs, and exposure history. Children with mild symptoms may require observation until return to baseline, whereas those with coma, respiratory depression, persistent hypoxia, seizures, hypotension, bradycardia, or suspected co-ingestion require hospital admission and possible pediatric intensive care. **[39]**

Observation time should be individualized according to the route of exposure and clinical course. Children exposed through inhalation may improve relatively quickly, whereas edible ingestion can produce delayed onset and prolonged neurological depression. Persistent symptoms beyond the usual emergency observation period, recurrent sedation, unstable vital signs, or inability to maintain hydration should be considered predictors of prolonged hospitalization. Clinical recovery is best defined as return to baseline mental status, stable age-appropriate vital signs, and absence of respiratory compromise. **[40]**

There is no specific antidote for THC intoxication; therefore, treatment focuses on supportive and symptomatic care. Oxygen supplementation, airway positioning, intravenous fluids, glucose correction, antiemetics, benzodiazepines for seizures, and mechanical ventilation may be required according to presentation. Activated charcoal has a limited role and may be considered only after recent significant ingestion when the airway is protected. Management decisions should prioritize clinical severity, because a positive urine cannabinoid screen alone does not indicate the need for aggressive intervention. **[39]**

Outcome is generally favorable, and most children recover completely within 24–48 hours. However, severe cases may require intensive care, respiratory support, or prolonged monitoring. Poorer short-term outcomes are most strongly associated with younger age, edible ingestion, high estimated THC dose,

coma, respiratory depression, cardiovascular instability, seizures, metabolic abnormalities, delayed presentation, and suspected co-ingestion. These variables should be incorporated into emergency triage pathways and future prognostic scoring systems. **[40]**

Evaluation is essential when exposure circumstances are unclear, delayed, recurrent, or inconsistent with the child's developmental ability. Documentation should include caregiver history, product description, estimated THC dose, storage location, timing of symptom onset, toxicology results, clinical course, and any evidence of unsafe supervision. Recurrent intoxication or exposure in infants should prompt consideration of child protection referral. Thus, pediatric cannabis intoxication is not only a clinical emergency but also a potential marker of environmental risk and caregiver neglect. **[39]**

Conclusion

Acute pediatric cannabis intoxication is usually self-limited, but severe outcomes may occur, especially in younger children after high-dose edible ingestion. Severity is best predicted by integrated clinical assessment, particularly depressed consciousness, respiratory compromise, cardiovascular instability, seizures, metabolic abnormalities, delayed presentation, and suspected co-ingestion, rather than by urine toxicology alone. Early risk stratification, supportive management, careful observation, and forensic evaluation of exposure circumstances are essential to improve outcomes and prevent recurrence.

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