

REVIEW ARTICLE



A Review on Interprofessional Collaboration in Poisoning and Overdose Management

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Abstract: The global burden of poisoning and overdose cases continues to rise, presenting significant challenges to healthcare systems worldwide. Effective management of these cases requires coordinated efforts across multiple healthcare disciplines. This review provides information about interprofessional collaboration in poisoning and overdose management, highlighting the inter-relationship between various healthcare professionals and their roles in patient care. The classification of poisoning types, common substances involved, and clinical manifestations, followed by detailed protocols for immediate response and treatment methods were also discussed. The roles of emergency medical technicians, nurses, physicians, pharmacists, laboratory technicians, toxicologists, and public health officials are elaborated, showing their unique contributions to patient care. Several barriers impede optimal care delivery, including limited access to antidotes, inadequate training, poor data collection systems, and communication gaps between healthcare professionals. Solutions for successful management includes integration of technology, standardized treatment protocols, and enhanced educational initiatives. Recent trends such as telemedicine platforms, mobile decision support tools, and digital health records show promise in improving collaborative care. The implementation of these solutions, combined with structured interprofessional education and clear communication channels, can significantly enhance patient outcomes in poisoning and overdose cases. Success in managing these cases depends on effective collaboration among healthcare professionals, supported by appropriate technologies and standardized protocols.

Keywords: Poisoning management; Interprofessional collaboration; Healthcare systems; Antidotes; Patient care.

1. Introduction

Poisoning and overdose represent significant global health challenges that demand immediate attention and coordinated healthcare responses. A poison refers to any substance that causes harmful effects when introduced into the body through ingestion, inhalation, or absorption, while overdose occurs when a substance is consumed beyond its recommended therapeutic quantity, potentially leading to severe health consequences [1]. The field of toxicology, which studies these harmful effects and their management, has evolved significantly over recent decades [2]. The global impact of poisoning and overdose is substantial and growing. Statistical data from the World Health Organization revealed approximately 250,000 deaths from intentional poisoning and 350,000 deaths from unintentional poisoning in 2000, predominantly affecting middle- and low-income countries [3]. By 2012, the total mortality from unintentional poisoning had escalated to approximately 1.93 million cases globally [4]. The United States alone reported 107,941 drug overdose-related deaths by 2022, with opioid-associated fatalities accounting for 73,838 cases [5].

The economic burden of poisoning and overdose extends beyond mortality statistics. Healthcare systems face mounting pressure from increased emergency department visits, extended hospital stays, and long-term rehabilitation requirements [6]. The societal impact manifests through lost productivity, strain on emergency services, and the emotional toll on families and communities [7]. Multiple factors contribute to poisoning and overdose incidents. These include accidental exposure to household chemicals, medication errors, substance abuse, occupational hazards, and environmental contamination [8]. The complexity of managing these cases stems from various challenges: the diverse nature of toxic substances, varying presentation of symptoms, time-sensitive treatment requirements, and the need for coordinated emergency responses [9].

Healthcare systems worldwide have implemented various strategies to address these challenges. These include establishing poison control centers, developing standardized treatment protocols, and creating emergency response networks [10]. However, the effectiveness of these measures often depends on the level of coordination between different healthcare professionals and the availability of resources [11]. The management of poisoning and overdose cases requires a multifaceted approach involving various healthcare professionals. Emergency medical technicians provide crucial first response, emergency physicians manage acute care,

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nurses monitor patient status, pharmacists guide antidote selection, laboratory technicians conduct vital analyses, and toxicologists provide specialized consultation [12].

2. Types and Manifestations of Poisoning and Overdose

2.1. Classification of Poisoning

Poisoning incidents can be categorized based on their intent, source, and exposure patterns. Accidental poisoning typically occurs through unintentional exposure, particularly affecting vulnerable populations such as children under 5 years and elderly individuals over 60 years [13]. These cases often result from medication errors, household chemical exposure, or contact with environmental toxins [14].

Intentional poisoning represents deliberate exposure to toxic substances, frequently associated with suicide attempts or substance misuse. Recent epidemiological studies indicate a concerning rise in intentional poisoning cases, particularly among adolescents and young adults [15]. Cases of deliberate poisoning by caregivers, known as Munchausen syndrome by proxy, though rare, require special attention due to their complex medical and psychological implications [16].

Environmental poisoning emerges from exposure to naturally occurring or anthropogenic toxins in air, water, or soil. Industrial pollutants, pesticides, and heavy metals constitute major environmental poisoning sources. Long-term exposure to these toxins can lead to chronic health conditions, while acute exposure may cause immediate severe symptoms [17].

2.2. Common Toxic Substances

2.2.1. Pharmaceutical Agents

Medication-related poisoning frequently involves analgesics, particularly acetaminophen, which remains a leading cause of drug-induced liver injury [18]. Cardiovascular medications, antidepressants, and benzodiazepines also feature prominently in poisoning cases. The rise in opioid-related overdoses has reached epidemic proportions in many regions, with synthetic opioids showing particularly high mortality rates [19].

Table 1. Common Toxidromes and Their Clinical Features

Toxidrome	Clinical Features	Common Causative Agents	Initial Management
Anticholinergic	Hyperthermia, mydriasis, dry skin/mucosa, delirium, urinary retention	Antihistamines, TCA, Jimsonweed	Supportive care, physostigmine (if indicated)
Cholinergic	Salivation, lacrimation, urination, bronchorrhea, bradycardia	Organophosphates, carbamates, nerve agents	Atropine, pralidoxime
Opioid	Miosis, respiratory depression, CNS depression	Heroin, fentanyl, prescription opioids	Naloxone, respiratory support
Sympathomimetic	Hypertension, tachycardia, hyperthermia, agitation	Cocaine, amphetamines, synthetic cathinones	Benzodiazepines, cooling
Sedative-Hypnotic	CNS depression, ataxia, slurred speech	Benzodiazepines, barbiturates, alcohol	Supportive care, flumazenil (if indicated)

2.2.2. Non-Pharmaceutical Substances

Household products, including cleaning agents, pesticides, and cosmetics, account for significant poisoning incidents, especially among children. Carbon monoxide poisoning, often from malfunctioning heating systems or poor ventilation, continues to cause substantial morbidity and mortality [20]. Industrial chemicals, particularly organic solvents and heavy metals, pose significant occupational hazards [21].

2.3. Clinical Manifestations

The presentation of poisoning and overdose varies considerably depending on the toxic agent, exposure route, and quantity involved. Neurological symptoms may include altered consciousness, seizures, or coma. Cardiovascular manifestations range from tachycardia to severe arrhythmias. Respiratory complications often present as dyspnea or respiratory depression [22].

Specific toxidromes - characteristic patterns of symptoms associated with particular toxic exposures - aid in rapid identification and treatment. The cholinergic toxidrome, seen in organophosphate poisoning, presents with increased secretions, bronchospasm, and

bradycardia. The sympathomimetic toxidrome, associated with stimulant overdose, manifests as hypertension, hyperthermia, and agitation [23].

The temporal progression of symptoms often provides crucial diagnostic information. While some toxins produce immediate effects, others may have delayed manifestations, complicating initial assessment and treatment decisions [24]. Recognition of these patterns requires careful clinical observation and documentation

3. Emergency Response and Initial Management

3.1. First Response Protocols

Initial response to poisoning and overdose requires systematic assessment and rapid intervention. The primary survey follows the established ABC (Airway, Breathing, Circulation) protocol, with particular attention to securing airways in cases of decreased consciousness or respiratory compromise [25]. Early recognition of life-threatening complications necessitates immediate stabilization measures before definitive treatment [26].

Environmental safety assessment constitutes a crucial component of first response. Responders must identify and mitigate ongoing exposure risks, particularly in cases involving volatile substances or chemical spills. Personal protective equipment requirements vary based on the nature of the toxic agent and exposure risk [27].

3.2. Assessment and Diagnosis

3.2.1. Clinical Evaluation

The initial assessment of poisoned patients demands meticulous history collection. Substance identification must include chemical names, brand names, and specific formulations involved in the exposure. Exposure quantification requires detailed documentation of the number of pills, concentration of liquids, or volume of substances ingested. Temporal factors encompass the precise time of exposure, onset of initial symptoms, and the pattern of symptom progression. The route of administration documentation includes specific details about ingestion, inhalation, injection, dermal contact, or ocular exposure. Circumstantial details note whether the exposure was accidental or intentional, the location where it occurred, and the presence of witnesses who might provide additional information.

Physical examination protocols must systematically evaluate multiple parameters. Vital sign assessment includes blood pressure patterns, noting any hypertension or hypotension, heart rate variations indicating tachycardia or bradycardia, respiratory rate abnormalities, and temperature fluctuations. Mental status evaluation incorporates Glasgow Coma Scale scoring, detailed pupillary response assessment, and orientation evaluation across all domains. Toxidrome markers require careful observation of specific constellations of vital sign abnormalities and physical findings that suggest particular toxic exposures. Organ system examination focuses on cardiac manifestations such as dysrhythmias, respiratory patterns including tachypnea or respiratory depression, neurological status including reflexes and muscle tone, hepatic tenderness or enlargement, and renal function indicators [28].

3.2.2. Laboratory Investigations

Initial laboratory evaluation begins with foundational studies. Complete blood count evaluation reveals potential hematologic effects of toxins and identifies infection markers that might influence treatment decisions. Basic metabolic panels illuminate electrolyte disturbances and acid-base status, critical for management planning. Liver function tests assess both acute hepatotoxicity and baseline synthetic function, guiding therapeutic interventions. Metabolic assessment through arterial blood gases provides crucial information about pH derangements, partial pressure of oxygen and carbon dioxide, and base deficit calculations. Lactate levels serve as markers of tissue hypoperfusion and cellular dysfunction. The osmolal gap calculation helps identify the presence of toxic alcohols and other osmotically active substances.

Drug level measurements require precise timing and interpretation. Acetaminophen levels correlate with the Rumack-Matthew nomogram for toxicity risk assessment. Salicylate measurements guide the need for enhanced elimination techniques. Specific drug assays encompass therapeutic drug monitoring for medications with narrow therapeutic windows, including digoxin, lithium, and anticonvulsants. Confirmatory testing employs sophisticated analytical techniques. Gas chromatography-mass spectrometry (GC-MS) provides definitive identification of volatile substances and many pharmaceutical agents. Liquid chromatography-mass spectrometry (LC-MS) enables detection of thermally labile compounds and large molecular weight substances. These advanced techniques require specialized laboratory capabilities and often involve send-out testing to reference laboratories [29].

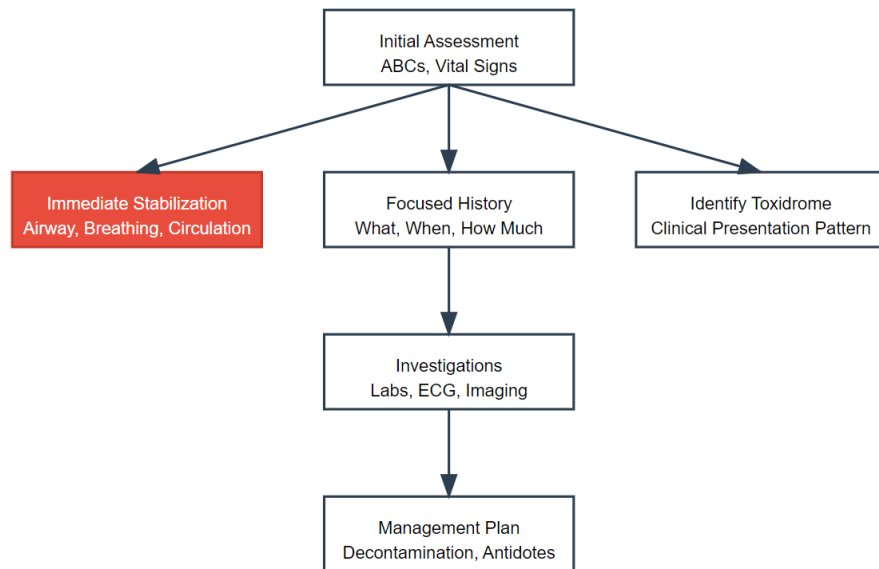
Table 2. Laboratory Investigations in Toxicology Assessment

Category	Essential Tests	Specific Toxin Screens	Timing Considerations
Basic Studies	CBC, BMP, LFTs	-	On presentation
Metabolic	ABG, lactate, osmolal gap	Toxic alcohols	Serial monitoring
Drug Levels	Acetaminophen, salicylate	Specific drug assays	4h post-ingestion
Confirmatory	GC-MS, LC-MS	Comprehensive drug screen	Based on clinical need

3.3. Initial Stabilization Measures

3.3.1. Decontamination

Gastrointestinal decontamination methods demand careful patient selection and timing considerations. Activated charcoal administration requires intact airway protective reflexes and early presentation within one hour of ingestion. The standard dosing involves 1g/kg body weight of activated charcoal mixed with water to form a slurry. The substance binds to toxins through surface adsorption, preventing systemic absorption. Multiple dose activated charcoal protocols interrupt enterohepatic circulation of specific toxins including carbamazepine, phenobarbital, and dapsone. Gastric lavage procedures involve orogastric tube placement and sequential gastric aspiration and lavage with normal saline. The technique requires endotracheal intubation for airway protection in patients with altered mental status. Whole bowel irrigation utilizes polyethylene glycol electrolyte solution administered at rates of 1-2 L/hour in adults until rectal effluent becomes clear. This method proves particularly valuable for sustained-release medication overdoses and body packers [30].

**Figure 1.** Initial Assessment and Management of the Poisoned Patient**Table 3.** Decontamination Methods and Their Indications

Method	Primary Indications	Contraindications	Effectiveness Window
Activated Charcoal	Most oral ingestions	Caustics, metals, alcohols	Within 1-2 hours
Gastric Lavage	Life-threatening ingestions	Caustics, volatiles	Within 1 hour
Whole Bowel Irrigation	Sustained release, body packers	Bowel obstruction, perforation	Variable
External Decontamination	Dermal/ocular exposures	None	Immediate
Enhanced Elimination	Specific toxins (lithium, salicylates)	Based on method	Variable

3.4. Supportive Care

Early supportive measures prioritize hemodynamic stabilization and organ system protection. Intravenous fluid resuscitation protocols typically begin with crystalloid solutions, with careful attention to volume status and electrolyte composition. Normal saline administration addresses volume depletion, while balanced electrolyte solutions help prevent iatrogenic acid-base disturbances. Central venous pressure monitoring guides fluid management in severe cases.

Temperature regulation involves active cooling measures for hyperthermia exceeding 39°C. Cooling blankets, ice packs to groin and axillae, and room temperature water misting with fan circulation represent standard interventions. Severe hyperthermia from sympathomimetic agents or malignant hyperthermia may require neuromuscular paralysis and mechanical ventilation [31].

3.5. Specific Antidotes

Time-critical antidote administration follows established protocols based on toxin identification and clinical severity. Naloxone administration for opioid overdose begins with 0.4-2 mg intravenously, with dose escalation up to 10 mg in resistant cases. Continuous naloxone infusions maintain therapeutic effect for long-acting opioids. N-acetylcysteine protocols for acetaminophen toxicity involve either 72-hour oral or 21-hour intravenous regimens, with dosing adjusted for patient weight. Snake envenomation requires specific antivenoms based on snake species identification, with initial doses followed by serial assessments of coagulation parameters and clinical response. Antidote administration demands close monitoring for adverse reactions including anaphylaxis, serum sickness, and paradoxical worsening of symptoms [32].

4. Antidotes and Treatment

4.1. Antidote Mechanisms and Selection

Antidotes function through multiple pharmacological pathways to neutralize or counteract toxic substances. Direct neutralization occurs when antidotes form stable complexes with toxins, rendering them inactive. Examples include digoxin-specific antibody fragments binding to digoxin molecules in the bloodstream. Competitive receptor antagonism involves antidotes occupying receptor sites, preventing toxin binding. This mechanism characterizes naloxone's action at opioid receptors and flumazenil's interaction with GABA receptors. Enhancement of physiological detoxification manifests through several pathways. Antidotes may increase enzymatic breakdown of toxins, augment natural elimination processes, or provide essential cofactors for detoxification. N-acetylcysteine exemplifies this mechanism by supplying cysteine for glutathione synthesis. Modification of toxic metabolite formation involves blocking specific metabolic pathways that generate harmful compounds. Fomepizole illustrates this principle by inhibiting alcohol dehydrogenase, preventing toxic metabolite formation from methanol or ethylene glycol [33].

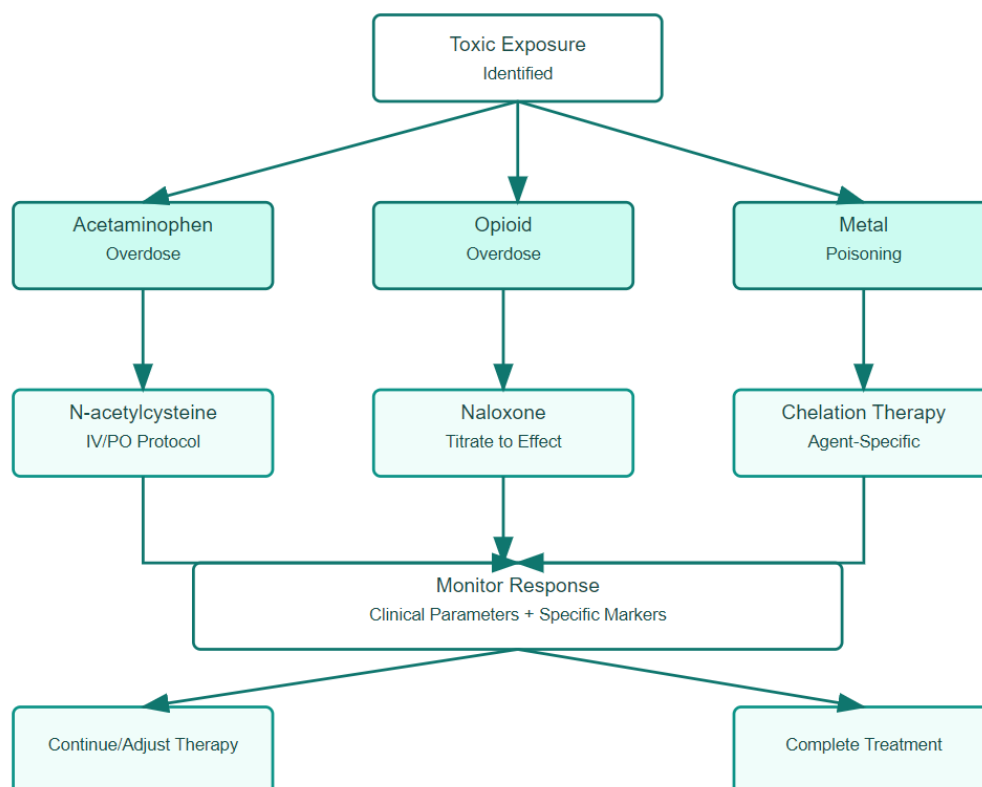


Figure 2. Antidote Selection Algorithm

4.2. Major Antidote Categories

4.2.1. Receptor Antagonists

Naloxone administration protocols reflect its pharmacokinetic properties. Initial doses range from 0.04 mg to 2.0 mg intravenously, with rapid dose escalation based on clinical response. The agent's distribution half-life spans 5-10 minutes, while its elimination half-life extends 60-90 minutes. Continuous infusion protocols maintain steady-state concentrations at 2/3 of the initial effective bolus dose per hour. Flumazenil reverses benzodiazepine effects through competitive antagonism at the GABA-benzodiazepine receptor complex. Initial doses start at 0.2 mg intravenously, with subsequent 0.3 mg doses at 60-second intervals up to 3 mg total. Contraindications include tricyclic antidepressant co-ingestion, seizure history, and chronic benzodiazepine use. Seizure risk increases in patients with benzodiazepine dependence due to abrupt withdrawal [34].

Table 4. Essential Antidotes and Their Applications

Antidote	Primary Indication	Mechanism of Action	Considerations
N-acetylcysteine	Acetaminophen toxicity	Glutathione precursor	IV or PO administration
Naloxone	Opioid overdose	Competitive antagonist	Short half-life may require repeated dosing
Fomepizole	Toxic alcohols	ADH inhibitor	Early administration crucial
Digoxin Fab	Digoxin toxicity	Antibody binding	Dose based on digoxin level/amount
Glucagon	β -blocker/CCB toxicity	cAMP activation	High doses often required
CaEDTA	Heavy metal poisoning	Chelation	Specific metal binding properties

4.2.2. Metabolic Antidotes

N-acetylcysteine protocols vary by administration route. Intravenous administration follows a 21-hour protocol: 150 mg/kg loading dose over 60 minutes, followed by 50 mg/kg over 4 hours, then 100 mg/kg over 16 hours. Oral protocols extend 72 hours: 140 mg/kg loading dose, followed by 70 mg/kg every 4 hours for 17 doses. Both regimens require dose adjustment for body weight and administration timing relative to acetaminophen ingestion. The agent's mechanism involves multiple protective pathways. Primary action supplies cysteine for glutathione synthesis, replenishing depleted stores. Secondary mechanisms include direct free radical scavenging, enhanced sulfate conjugation, and mitochondrial energy substrate provision. Treatment efficacy correlates with early administration, ideally within 8-10 hours of acetaminophen ingestion [35].

4.2.3. Chelating Agents

Metal poisoning treatment employs specific chelating agents based on metal properties and toxicity patterns. Dimercaprol (BAL) binds arsenic, gold, and mercury, forming stable metal complexes. Administration requires deep intramuscular injection at 2.5-5 mg/kg every 4-6 hours. Succimer (DMSA) provides oral chelation for lead poisoning, with typical dosing at 10 mg/kg every 8 hours for 5 days, followed by 12-hour intervals for 14 days. Deferoxamine specifically chelates iron, administered as continuous intravenous infusion at 15 mg/kg/hour for acute iron poisoning. Calcium EDTA demonstrates efficacy in lead poisoning, requiring continuous intravenous administration at 1000-1500 mg/m²/day. Chelation protocols demand careful monitoring of metal levels, renal function, and essential mineral status [36].

4.3. Treatment

4.3.1. Gastrointestinal Decontamination

Gastrointestinal decontamination protocols incorporate risk-benefit assessment matrices considering substance toxicity, time from ingestion, patient factors, and anticipated clinical course. Activated charcoal administration requires specific conditions: intact airway protection, toxic substance amenable to binding, and presentation within one hour of ingestion. Standard dosing employs 1g/kg body weight mixed with water in 8:1 ratio. Substances poorly adsorbed by activated charcoal include alcohols, metals, mineral acids, alkalis, and lithium. Whole bowel irrigation utilizes polyethylene glycol electrolyte solution administered at 1-2 L/hour in adults or 25-40 mL/kg/hour in children until clear rectal effluent appears. Indications include ingestion of sustained-release medications, iron tablets, drug packets, or heavy metals. Contraindications encompass bowel obstruction, perforation, ileus, hemodynamic instability, and compromised airway [37].

Table 5. Risk Stratification in Poisoned Patients

Risk Level	Clinical Features	Monitoring Requirements	Disposition
Low	Minimal symptoms, non-toxic amount	4-6 hour observation	Discharge with follow-up
Moderate	Mild-moderate symptoms, concerning amount	Continuous monitoring 12-24h	Extended observation
High	Severe symptoms, lethal amount	ICU monitoring	ICU admission
Critical	Life-threatening features	Invasive monitoring	Immediate critical care

4.3.2. Enhanced Elimination

Multiple-dose activated charcoal protocols interrupt enterohepatic and enterovascular circulation of specific toxins. Administration involves 0.5 g/kg every 4-6 hours, continuing until clinical improvement occurs. Target substances include carbamazepine, phenobarbital, quinine, dapsone, and theophylline. Urinary alkalization employs sodium bicarbonate infusion targeting urine pH 7.5-8.5. The technique enhances elimination of weak acids through ion trapping mechanisms. Candidates include salicylates, phenobarbital, chlorpropamide, and chlorophenoxy herbicides. Extracorporeal elimination techniques incorporate specific indications and prescription parameters. Hemodialysis removes toxins through diffusion across semipermeable membranes, effective for substances with low molecular weight, low protein binding, and small volume of distribution. Hemoperfusion employs activated charcoal or resin cartridges to adsorb toxins directly from blood. Indications include severe lithium toxicity (levels >4 mEq/L), salicylate poisoning with altered mental status or levels >100 mg/dL, toxic alcohol ingestion with severe acidosis, and metformin-associated lactic acidosis [38]

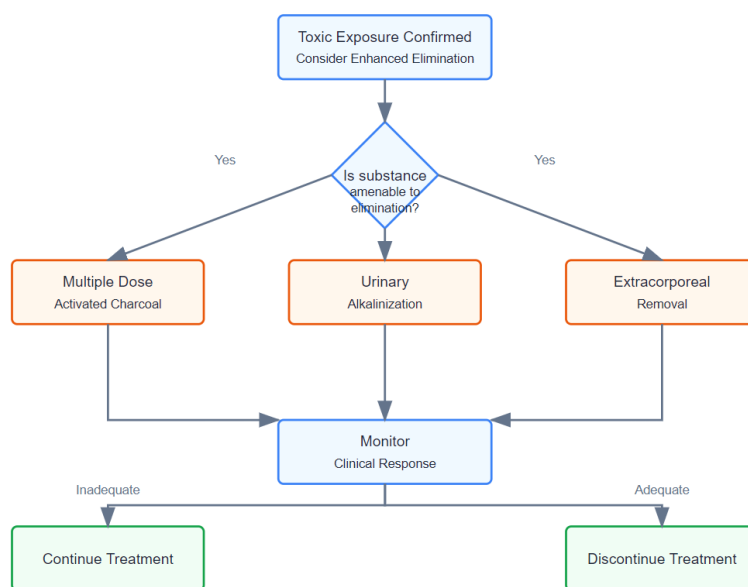


Figure 3. Decision-Making Process for Enhanced Elimination Techniques

4.4. Monitoring

Treatment monitoring protocols incorporate multimodal assessment strategies. Vital sign monitoring includes continuous cardiac telemetry, automated blood pressure measurement, pulse oximetry, and core temperature tracking. Serial neurological assessments document Glasgow Coma Scale scores, pupillary responses, and development of focal deficits. Laboratory monitoring follows substance-specific protocols. Acetaminophen levels obtain at 4 hours post-ingestion correlate with toxicity risk on the Rumack-Matthew nomogram. Salicylate levels require q2-4 hour measurement during active toxicity. Toxic alcohol cases need serial osmolal gap calculations and anion gap measurements. Organ dysfunction markers include troponin for cardiac injury, creatine kinase for rhabdomyolysis, transaminases for hepatotoxicity, and renal function tests. Treatment complications monitoring encompasses fluid overload, electrolyte imbalances, acid-base disturbances, and antidote-related adverse effects [39]

5. Healthcare Professional Roles and Responsibilities

5.1. Emergency Medical Technicians

EMTs implement structured assessment protocols beginning with scene safety evaluation and personal protective equipment requirements. Initial patient assessment follows the ABCDE (Airway, Breathing, Circulation, Disability, Exposure) approach. Airway management options include positioning, suctioning, and basic airway adjuncts. Breathing support ranges from supplemental oxygen to bag-valve-mask ventilation. Stabilization measures incorporate specific protocols based on toxidrome recognition. Opioid overdose management includes naloxone administration via intranasal or intramuscular routes. Hypoglycemia treatment employs oral glucose for alert patients or intramuscular glucagon for unconscious patients.

Transport decisions balance factors including patient condition, antidote availability, destination facility capabilities, and transport time. Communication protocols require structured handoff reports detailing exposure information, interventions performed, and clinical response [40]

5.2. Emergency Department Personnel

5.2.1. Emergency Physicians

Emergency physicians execute systematic poisoning management protocols incorporating immediate stabilization measures with definitive care planning. Initial patient assessment involves primary survey focusing on airway patency, respiratory adequacy, circulatory status, and neurological function. Secondary survey encompasses detailed physical examination, toxidrome identification, and evaluation for complications. Decision-making algorithms guide critical interventions: endotracheal intubation criteria, vasopressor initiation parameters, antidote administration timing, and decontamination method selection. Laboratory test ordering follows evidence-based protocols tailored to suspected toxins. Toxicology consultation triggers include severe poisoning, unknown substances, pregnancy complications, and pediatric cases.

Disposition planning incorporates risk stratification metrics: vital sign stability, mental status, organ dysfunction severity, and anticipated clinical course. Admission criteria encompass specific parameters: respiratory compromise requiring ventilatory support, hemodynamic instability necessitating vasopressor therapy, severe metabolic derangements, or high-risk substances with delayed toxicity [41]

5.2.2. Emergency Nurses

Emergency nurses implement structured monitoring protocols including continuous cardiac telemetry interpretation, blood pressure trend analysis, respiratory pattern assessment, and neurological status evaluation. Medication administration responsibilities involve antidote preparation, cross-checking procedures, infusion rate calculations, and timing documentation. Clinical progression monitoring includes hourly vital signs, intake/output measurement, serial neurological assessments, and ECG interpretation. Nurses track specific markers: urine output rates, cognitive status changes, bleeding manifestations, and skin color variations. Documentation protocols capture intervention timing, clinical responses, adverse reactions, and patient disposition details [42].

5.3. Clinical Support Services

5.3.1. Clinical Pharmacists

Clinical pharmacists perform medication therapy management incorporating substance identification, toxicity assessment, and treatment protocol development. Dosing calculations account for patient-specific factors: body weight, organ function, concurrent medications, and comorbidities. Drug interaction screening evaluates potential adverse combinations, particularly with antidotes and supportive medications. Antidote preparation protocols specify mixing procedures, stability requirements, and administration guidelines. Complex antidote regimens, such as N-acetylcysteine protocols, require detailed infusion rate calculations and adjustment parameters. Monitoring responsibilities include serum drug levels, therapeutic responses, and adverse effect manifestations. Prevention program participation involves medication safety education, proper storage guidelines, and poison prevention strategies. Pharmacists develop protocols for high-risk medications, maintain antidote stockpiles, and coordinate with regional poison centers [43]

5.3.2. Laboratory Personnel

Laboratory technicians execute time-sensitive analytical protocols for toxicology specimens. Chemistry panel processing includes electrolyte measurement, liver function assessment, and kidney function evaluation. Toxicology screening employs immunoassay techniques for common substances and gas chromatography-mass spectrometry for comprehensive drug detection. Specialized testing protocols address specific toxins: acetaminophen levels, salicylate concentrations, heavy metal analysis, and therapeutic drug monitoring. Quality control procedures ensure result accuracy through calibration verification and reference range validation. Critical value reporting follows established algorithms with direct communication to treating physicians [44].

5.4. Specialized Services

5.4.1. Clinical Toxicologists

Clinical toxicologists provide specialized consultation incorporating substance-specific management protocols, antidote selection criteria, and elimination technique recommendations. Case evaluation includes exposure circumstance analysis, dose-toxicity correlation, and anticipated clinical course prediction. Management recommendations specify antidote dosing regimens, monitoring parameters, and therapeutic endpoints. Complex case consultation addresses delayed-release preparations, multiple substance ingestions, and pregnancy-related exposures. Long-term management strategies incorporate rehabilitation planning, psychiatric evaluation needs, and prevention of future exposures [45].

5.4.2. Poison Control Center

Poison control centers maintain computerized databases containing over 1,000,000 substance entries with specific toxicity information and treatment protocols. Staff specialists provide telephone consultation using standardized assessment algorithms and

triage protocols. Management recommendations incorporate substance-specific interventions, home observation criteria, and hospital referral indicators. Database maintenance includes regular updates on new substances, emerging treatment modalities, and antidote availability. Centers track regional poisoning trends, maintain antidote inventories, and coordinate responses to mass casualty incidents [46]

5.4.3. Public Health Officials

Public health officials implement surveillance systems capturing poisoning incident data, exposure patterns, and outcome metrics. Data collection protocols standardize reporting requirements across healthcare facilities and poison centers. Trend analysis identifies emerging threats, high-risk populations, and prevention opportunities. Mass exposure response coordination involves multiple agency collaboration, resource allocation, and public communication strategies. Prevention programs target specific risks: household chemical safety, medication storage practices, and occupational exposure protection. Implementation strategies incorporate community education, healthcare provider training, and policy development [47]

6. Challenges in Poisoning and Overdose Management

6.1. Resource Limitations

6.1.1. Antidote Availability

Healthcare facilities face multiple antidote access barriers impacting patient care delivery. Essential antidotes including fomepizole for toxic alcohol ingestion carry acquisition costs exceeding \$1000 per treatment course. Digoxin immune Fab fragments require climate-controlled storage conditions with shelf lives under 24 months. Snake antivenoms demand species-specific stocking patterns while maintaining cold chain requirements. Rural healthcare facilities contend with limited storage capacity, financial constraints affecting inventory maintenance, and challenging transport logistics for time-sensitive medications. Regional antidote networks attempt coordination, but geographic distances impede rapid transfer protocols. Smaller hospitals struggle maintaining comprehensive antidote stocks, particularly for rarely used but critical agents like hydroxocobalamin for cyanide poisoning [48]

6.1.2. Laboratory Capabilities

Laboratory infrastructure limitations affect toxicology testing availability. Basic chemistry analyzers may lack capacity for specialized toxicology assays including acetaminophen levels, salicylate concentrations, and therapeutic drug monitoring. Gas chromatography-mass spectrometry equipment requires substantial capital investment and specialized technical expertise. Specimen transport to reference laboratories introduces significant delays: courier scheduling constraints, weather-related interruptions, and weekend service limitations. Point-of-care testing development faces technical challenges including matrix effects, cross-reactivity issues, and calibration requirements. Current rapid testing options primarily address drugs of abuse, leaving gaps in comprehensive toxin screening [49]

6.2. Information Management

6.2.1. Data Collection

Surveillance system deficiencies create substantial data gaps. Current systems lack standardized poisoning classification schemes, consistent outcome measures, and uniform reporting requirements. Rural regions often operate paper-based systems without electronic data capture capabilities. Urban centers utilize diverse electronic health records with limited interoperability. Hospital systems employ varying toxicology coding practices, complicating data aggregation efforts. Poison control centers maintain separate databases using different classification systems. Emergency medical services record exposure data through distinct documentation platforms. These disparate systems create challenges in tracking regional poisoning patterns, identifying emerging threats, and measuring intervention effectiveness [50].

6.2.2. Clinical Documentation

Documentation deficiencies impact both acute care delivery and research capabilities. Exposure histories frequently omit critical details: exact substance quantities, specific formulations, co-ingestants, and timing of exposure. Intervention documentation lacks precise timing records for antidote administration, decontamination procedures, and clinical reassessments. Outcome documentation varies significantly across institutions. Discharge summaries may exclude important clinical parameters, laboratory value trends, and follow-up recommendations. Research efforts encounter difficulties extracting meaningful data from inconsistent documentation formats. Quality improvement initiatives struggle measuring protocol adherence without standardized documentation elements [51].

6.3. Professional Barriers

6.3.1. Training Deficiencies

Healthcare professional education programs provide limited toxicology exposure. Medical school curricula typically allocate fewer than 10 hours to toxicology instruction. Emergency medicine residency programs vary widely in toxicology rotation requirements. Primary care physicians receive minimal ongoing toxicology updates despite frequently encountering poisoned patients. Nursing education programs often lack detailed toxicology management protocols. Pharmacist training focuses primarily on medication interactions rather than acute poisoning management. Emergency medical technicians receive basic toxidrome recognition training without advanced management principles. Rural providers face particular challenges accessing continuing education programs in toxicology [52].

6.3.2. Communication Issues

Hierarchical healthcare structures create communication barriers affecting patient care. Junior staff members may hesitate reporting concerns to senior colleagues. Nursing observations might not receive appropriate physician attention. Pharmacy recommendations may face resistance from medical staff. Handoff protocols lack standardization across departments and institutions. Critical information transfer suffers during shift changes, patient transfers, and interdepartmental movements. Toxicology consultation mechanisms often involve multiple communication steps, creating delays in expert input. Time-sensitive decisions may proceed without specialty guidance due to consultation barriers [53].

6.4. Social and Cultural Factors

6.4.1. Stigma

Substance abuse-related poisonings face significant stigmatization affecting care delivery. Patients may delay seeking treatment fearing legal consequences or social judgment. Emergency department staff may display negative attitudes toward repeated overdose presentations. Healthcare providers might minimize symptoms or withhold optimal care based on personal biases. Documentation practices sometimes reflect prejudicial attitudes through inappropriate terminology or dismissive language. Resource allocation decisions may disadvantage patients with substance use disorders. Follow-up care arrangements often receive less attention for stigmatized patient populations [54].

6.4.2. Cultural Barriers

Cultural factors significantly influence poisoning care delivery. Traditional medicine practices may promote potentially toxic remedies without scientific validation. Language barriers complicate accurate exposure history collection and treatment plan communication. Religious beliefs may affect acceptance of certain treatment modalities. Family decision-making patterns vary across cultural groups, affecting consent processes and treatment decisions. Cultural healing practices may interact adversely with standard medical protocols. Healthcare providers often lack cultural competency training specific to toxicology scenarios. Educational materials rarely address diverse cultural perspectives on poisoning prevention and treatment [55].

7. Strategic Solutions

7.1. Technological Innovations

7.1.1. Telemedicine

Telemedicine platforms incorporate multiple technological components enhancing toxicology care delivery. High-definition video conferencing systems enable detailed patient examination, including pupillary response assessment, movement disorders evaluation, and skin finding documentation. Secure data transmission protocols support real-time sharing of electrocardiograms, laboratory values, and diagnostic imaging. Remote specialist consultation programs connect rural emergency departments with toxicology centers. Direct audio-visual communication allows bedside staff to receive immediate guidance on procedures including activated charcoal administration, antidote preparation, and enhanced elimination techniques. Digital image capture systems permit detailed documentation of pill fragments, chemical containers, and plant materials for identification. Store-and-forward technologies enable asynchronous specialist review of complex cases. Mobile device integration facilitates rapid consultation initiation from pre-hospital settings. Translation services integration addresses language barriers during toxicology consultations [56].

7.1.2. Clinical Decision Support Systems

Advanced algorithmic systems incorporate machine learning capabilities for toxin identification. Natural language processing analyzes patient symptoms, physical findings, and laboratory data to suggest potential toxins. Pattern recognition software evaluates trends in vital signs and laboratory values to predict clinical deterioration.

Mobile applications provide offline access to comprehensive toxicology databases. Integrated calculators determine toxic alcohol gaps, antidote dosing, and elimination rates. Barcode scanning capabilities identify pharmaceutical products and access safety information. Electronic health record integration enables automated screening of medication lists for interactions. Real-time alerts notify providers of critical laboratory values, concerning vital sign trends, and required monitoring parameters. Clinical pathway automation guides providers through evidence-based management protocols [57].

7.2. Treatment Protocols

Standardized treatment protocols incorporate detailed assessment algorithms, intervention timing guidelines, and monitoring parameters. Initial evaluation protocols specify required vital signs, laboratory studies, and diagnostic tests based on suspected toxins. Decontamination protocols outline specific indications, contraindications, and procedural steps for various methods. Antidote administration guidelines detail weight-based dosing calculations, preparation instructions, and administration rates. Enhanced elimination protocols specify indications for multiple-dose activated charcoal, urinary alkalization, and extracorporeal treatments. Monitoring protocols establish frequency of vital sign measurement, laboratory testing, and clinical reassessment. Documentation templates capture essential elements: exposure details, intervention timing, clinical response, and disposition planning. Quality assurance metrics evaluate protocol adherence, timing of critical interventions, and patient outcomes. Regular review processes incorporate new evidence and treatment modalities [58]. Reporting systems standardization facilitates data sharing across institutions. Electronic templates ensure complete capture of required elements while maintaining efficiency. Integration mechanisms link poison center records with hospital documentation systems. Automated data extraction supports research initiatives and quality improvement efforts [59].

7.3. Educational Programs

Healthcare professional education incorporates diverse learning modalities. High-fidelity simulation scenarios replicate complex poisoning cases, allowing practical skill development without patient risk. Virtual reality platforms demonstrate proper decontamination techniques and antidote administration procedures. Case-based learning modules present real-world scenarios with expert commentary. Continuing education programs address emerging threats, new treatment modalities, and updated protocols. Regular toxicology updates incorporate regional poisoning trends and treatment outcomes. Distance learning platforms extend educational reach to rural providers. Community education initiatives target specific populations and scenarios. School-based programs address household chemical safety and medication storage. Workplace training focuses on occupational exposure prevention and initial response protocols. Social media campaigns deliver real-time alerts about emerging threats and prevention strategies [60, 61].

7.4. System-Level Improvements

Regional antidote networks establish sharing agreements and storage protocols. Central stockpile locations maintain adequate supplies of expensive or rarely-used antidotes. Transportation agreements ensure rapid transfer capabilities. Inventory management systems track antidote locations, quantities, and expiration dates. Resource optimization strategies include cost-sharing arrangements between facilities. Alternative treatment protocols account for resource limitations while maintaining care quality. Coordination mechanisms facilitate patient transfer to specialized centers when necessary. Quality metrics include structure, process, and outcome measures. Regular audits evaluate protocol compliance, intervention timing, and patient outcomes. Feedback systems provide real-time performance data to healthcare teams. Continuous improvement processes incorporate audit findings into protocol updates and system enhancements [62, 63].

8. Conclusion

The management of poisoning and overdose cases presents complex challenges requiring coordinated responses from multiple healthcare disciplines. Development of specific antidotes and enhancement of supportive care protocols have improved patient outcomes. Implementation of standardized treatment guidelines has promoted consistency in care delivery across different healthcare settings. However, substantial challenges persist. Limited resource availability, particularly in developing regions, continues to affect care quality. Gaps in professional training, communication barriers between healthcare providers, and inadequate surveillance systems hamper optimal care delivery. Social stigma and cultural factors further complicate effective intervention implementation. The path forward requires sustained commitment to several key initiatives. Integration of digital health technologies offers promising solutions for improving access to specialized expertise and supporting clinical decision-making. Standardization of care protocols, while maintaining flexibility for local resources and needs, provides essential frameworks for consistent care delivery. Enhanced professional education and training programs ensure healthcare providers maintain current knowledge and skills. Success in managing poisoning and overdose cases ultimately depends on effective collaboration among healthcare professionals. The unique contributions of emergency responders, physicians, nurses, pharmacists, laboratory personnel, and toxicologists must be coordinated through clear communication channels and shared understanding of treatment goals. Support from public health systems and poison control centers remains essential for comprehensive care delivery.

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