

Paramedics' Role In The Early Detection And Treatment Of Poisoning And Overdose

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Abstract

Poisoning and overdose constitute a significant global health burden, with acute poisoning causing substantial morbidity and mortality worldwide. Paramedics play a pivotal role in the early detection and treatment of these emergencies during the prehospital phase. This review comprehensively examines the role of paramedics in managing poisoning and overdose, focusing on their interventions, protocols, challenges, and future directions. Key aspects of prehospital management include scene safety assessment, clinical evaluation, utilization of point-of-care diagnostics, airway and circulatory support, antidote administration, and decontamination. Paramedics face challenges such as limited diagnostic tools, incomplete exposure information, occupational hazards, and complex legal and ethical issues surrounding antidote administration. Innovations in artificial intelligence-powered biosensors, portable toxicology kits, community paramedicine programs, and interdisciplinary collaboration between emergency medical services, public health, and mental health services represent promising avenues for enhancing prehospital care in poisoning and overdose. Strengthening paramedic training, integrating real-time toxicological support, and developing evidence-based protocols are essential for optimizing patient outcomes. This review highlights the critical role of paramedics in the early recognition and management of poisoning and overdose emergencies while emphasizing the need for continued research and innovation to address the evolving challenges in prehospital toxicology.

Keywords Paramedics, Poisoning, Drug Overdose, Prehospital Care, Toxicology, Emergency Medicine, Early Detection, Field Diagnostics, Public Health.

1. Introduction

The epidemiological context of poisoning and overdose reveals a substantial global health burden, with acute poisoning responsible for significant morbidity and mortality worldwide. According to the World Health Organization (WHO), poisoning causes approximately half a million deaths annually, with pesticide poisoning alone resulting in about 150,000 fatalities each year. The global incidence varies by region, with low- and middle-income countries (LMICs) bearing a disproportionate share of unintentional poisoning

deaths, particularly among children. In high-income countries like the United States, more than 2.2 million cases of poisoning are reported annually, with significant impacts on children under five years of age. Regional data indicate varying patterns; for instance, in Saudi Arabia, common toxic agents include household chemicals and pharmaceuticals, whereas in England and Wales, drug poisoning deaths have steadily increased, with opiates and cocaine as primary contributors (Salem et al., 2024).

Early prehospital recognition of poisoning and overdose is critical for reducing mortality and morbidity. Timely identification and management can prevent progression to severe toxicity and allow for rapid initiation of life-saving interventions such as airway management, antidote administration, and decontamination. Studies show that patients arriving to medical care early have higher chances of recovery, with delays increasing the risk of complications and death. Prehospital providers play a pivotal role in early triage, stabilizing patients, and expediting transfer to definitive care, which is especially vital given that a significant proportion of fatal poisonings occur before hospital arrival. Rapid assessment protocols, including ABCDE (Airway, Breathing, Circulation, Disability, Exposure), are foundational in early management (Reda et al., 2023).

Paramedics, as frontline responders, are uniquely positioned to detect and initiate treatment for toxicological emergencies during the prehospital phase. Their role encompasses initial assessment, administration of antidotes (e.g., naloxone for opioid overdose), oxygen therapy (e.g., for carbon monoxide poisoning), and rapid transport decisions. Research highlights the evolving complexity of paramedic care amidst rising drug poisoning incidences, necessitating expanded skills and protocols for varied substances and co-intoxications. Challenges include underrecognition in some cases and balancing rapid response with thorough assessment. Moreover, paramedics' engagement in harm reduction and alternative care pathways is emerging as a critical area to address the broader public health impact (Koskela et al., 2023).

Despite the critical frontline role of paramedics, gaps remain in the literature regarding standardized protocols, training, and integration of toxicology expertise into prehospital settings. Underreporting of fatal poisonings to poison control centers indicates surveillance limitations, and there is a need for enhanced data capture and real-time toxicology support for paramedics. Additionally, there is limited evidence on best practices for paramedics managing complex or multi-drug poisonings in diverse settings, underscoring the need for further research to optimize prehospital toxicology care (Kharel et al., 2025).

This review aims to comprehensively examine the role of paramedics in the early detection and treatment of poisoning and overdose. The specific objectives are to delineate paramedic interventions in toxicological emergencies, evaluate existing protocols and training, identify challenges and gaps in prehospital toxicology management, and propose strategies to enhance paramedic capacity and patient outcomes in poisoning incidents. By addressing these aims, this review seeks to fill crucial gaps in knowledge and support the development of evidence-based prehospital care frameworks for poisoning and overdose emergencies.

2. Background and Pathophysiological Overview

2.1 Poisoning and Overdose: Definition and Classification

Poisoning and overdose refer to harmful or potentially lethal exposures to toxic substances. These can be broadly classified into intentional (e.g., suicide attempts) and unintentional (accidental) poisonings. Common toxic agents include pharmaceuticals (such as opioids and benzodiazepines), household chemicals, illicit drugs, and industrial toxins. Understanding this classification is vital for paramedics to anticipate clinical presentations and plan interventions accordingly (Müller & Desel, 2013).

2.2 Pathophysiology of Common Poisonings

The mechanisms of toxicity vary but often lead to central nervous system (CNS) depression, respiratory failure, and metabolic acidosis. Specific toxic syndromes include:

- **Anticholinergic syndrome:** characterized by dry skin, dilated pupils, tachycardia (Arora et al., 2018).
- **Cholinergic syndrome:** includes excessive salivation, muscle weakness, and bronchorrhea (Arora et al., 2018).
- **Opioid toxicity:** marked by respiratory depression, miosis, and decreased consciousness (Arora et al., 2018).
- **Sympathomimetic syndrome:** presents with agitation, hypertension, tachycardia (Arora et al., 2018).
- **Sedative-hypnotic poisoning:** often causes CNS depression, ataxia, and respiratory compromise (Arora et al., 2018).

Paramedics should recognize these patterns quickly as they influence management strategies.

2.3 Time-Critical Nature of Interventions

The interval between toxin exposure, symptom onset, and recognition critically affects patient outcomes. Early identification and stabilization by paramedics in the prehospital setting improve survival and reduce complications. Key actions include airway management, ventilation support, circulatory stabilization, and early antidote administration when indicated. Prehospital triage and recognition accuracy have shown to improve with experienced EMS providers, although some poisonings may initially escape detection, especially if the patient presents with decreased consciousness requiring fluid resuscitation or intubation (Barefoot et al., 2021).

3. Methods

This review employed a comprehensive qualitative synthesis approach to examine the role of paramedics in managing poisoning and overdose emergencies in the prehospital setting. An extensive literature search was conducted across multiple databases, including PubMed, Scopus, and Google Scholar, focusing on peer-reviewed articles, official clinical guidelines, regional toxicology reports, and EMS protocols published up to 2025. Key search terms included "paramedics," "poisoning," "overdose," "prehospital care," "toxicology," "emergency medicine," "early detection," and "prehospital interventions."

Inclusion criteria encompassed studies and reports addressing paramedic assessments, diagnostic capabilities, treatment protocols, and challenges in poisoning cases, with emphasis on both intentional and unintentional exposures. Data sources were critically appraised for relevance, methodological rigor, and applicability to EMS settings. The review specifically evaluated paramedic interventions such as airway management, antidote administration, decontamination procedures, and transport decisions.

Qualitative thematic analysis was used to identify recurrent themes related to paramedic competencies, diagnostic tool utilization, training adequacy, legal and ethical considerations, and emerging technological innovations such as point-of-care toxicology testing and AI-enhanced biosensors. The review also incorporated data on community paramedicine models and interdisciplinary collaborations that extend the paramedic role beyond acute care. Gaps in surveillance, standardized guidelines, and prehospital toxicology integration were highlighted to inform recommendations for improving EMS care quality.

This methodology allowed a comprehensive overview of current evidence, identifying strengths and limitations in paramedic response to poisoning and overdose incidents, and supporting strategies for enhancement of patient outcomes through optimized prehospital care frameworks.

4. Epidemiology and Burden of Poisoning and Overdose

Poisoning and overdose constitute a significant global public health challenge, contributing substantially to morbidity and mortality worldwide. The Global Burden of Disease study estimates that unintentional poisoning caused approximately 84,278 deaths globally in 2019, accounting for a large number of disability-adjusted life years (DALYs) lost due to both morbidity and premature mortality. Mortality rates vary widely by region, with lower- and middle-income countries showing substantial burdens, though high-income countries experience rising trends in specific poisoning types such as opioid overdoses (Reda et al., 2023).

4.1 Global Statistics

Worldwide, the global age-standardized mortality rate from unintentional poisoning has shown some decline over recent decades but remains significant. For example, South Asia saw a reduction in death rates from unintentional poisoning from 986.2 per 100,000 population in 1990 to 661.3 per 100,000 in 2019, reflecting public health interventions yet highlighting persistent risk. In the United States, recent data reveal that there were over 100,000 deaths from preventable poisoning in 2023, with a death rate of 29.9 per 100,000 population; males consistently show higher mortality rates. Canadian reports similarly document tens of thousands of opioid-related poisoning hospitalizations and emergency department visits annually, with trends stabilizing but still indicating a large healthcare burden (Khan et al., 2023).

4.2 Demographic and Geographic Variations

Poisoning incidences and outcomes exhibit considerable demographic disparities. In pediatric populations, Aboriginal children have higher hospitalization rates for poisoning compared to non-Aboriginal children, with risk factors including male sex, socioeconomic disadvantage, and geographic remoteness. Among adults, risk is notably elevated in middle-aged and older populations, with a concerning increase in overdose deaths among those aged 65 and older. Males consistently demonstrate higher risk across many age groups (Lee et al., 2019).

Geographically, rural areas often report higher odds of fatal overdose events than urban centers, a disparity attributed to limited access to healthcare resources and greater socioeconomic stresses prevalent in rural communities. However, urban areas show higher rates of recurrent overdoses, contributing to elevated overall overdose mortality. The spatial and temporal distribution of overdose risk can vary according to region, with some areas demonstrating rapid escalation of fatal events over short periods (Hu et al., 2022).

4.3 Trends in Opioid, Alcohol, and Polypharmacy Overdoses

The opioid epidemic remains a major factor driving poisoning-related morbidity and mortality in many countries. Opioids are involved in most unintentional overdose deaths, often in combination with other substances such as alcohol, benzodiazepines, and stimulants. Polysubstance overdose, involving multiple drugs, is increasingly common, complicating clinical management and harm reduction efforts. The rise in synthetic opioids like fentanyl and its analogs has led to dramatic increases in overdose fatalities, especially when combined with other depressants or stimulants (Peppin et al., 2020).

Alcohol poisoning mortality has also risen, with concomitant increases in alcohol-related emergency visits, particularly among older adults. Polypharmacy overdoses, which involve combinations of prescription medications, illicit drugs, and alcohol, complicate detection and treatment in prehospital settings and contribute to increasing healthcare utilization (Humphreys & Shover, 2023).

4.4 Temporal Patterns and Socioeconomic Influences

Socioeconomic status plays a crucial role in the risk and outcomes of poisoning and overdose. Individuals in lower socioeconomic strata have higher rates of substance use, overdose, and fatal poisoning events, linked to material deprivation and social determinants of health. Regional disparities in poisoning burden often reflect underlying socioeconomic inequalities (Pawer et al., 2021).

Temporal patterns show shifts such as increased overdose risks during economic downturns, social isolation periods, and changes in drug supply dynamics. Rural-urban differences in overdose risk have been documented, with rural areas facing higher fatality risks per event, while urban areas endure more recurrent episodes. These factors underscore the complexity of addressing poisoning epidemiology through targeted public health and prehospital care interventions (Hu et al., 2022).

5. Early Detection and Assessment by Paramedics

5.1 Scene Safety and Environmental Assessment

The initial priority for paramedics at a suspected poisoning or overdose incident is ensuring scene safety, both for responders and victims. Identifying hazardous materials and potential exposure sources is critical to prevent secondary contamination or injury. Paramedics should conduct a rapid environmental assessment for chemical agents, vapors, or residues consistent with toxic exposure, utilizing their training in hazardous materials (HAZMAT) awareness and detection techniques (khanizade et al., 2025).

Coordination with specialized HAZMAT teams and law enforcement is essential when volatile substances or large-scale chemical exposures are suspected. Establishing zones of contamination (hot, warm, cold) guides the safe approach and treatment areas, with full personal protective equipment (PPE) required in the hot zone where toxin levels are highest. Effective crowd control and securing the perimeter mitigate risks of cross-contamination and facilitate paramedic intervention under safe conditions (Berry & Perera, 2022).

5.2 Clinical Assessment

Paramedics perform thorough clinical evaluation using established neurological assessment scales such as AVPU (Alert, Voice, Pain, Unresponsive) and the Glasgow Coma Scale (GCS) to rapidly determine consciousness level and neurological status. Pupillary examination can reveal signs of specific toxidromes, for example, pinpoint pupils in opioid overdose or dilated pupils in anticholinergic toxicity (Ajumobi et al., 2022).

Recognition of characteristic toxidromes is pivotal for rapid differential diagnosis and guiding early treatment decisions. Typical toxidromes include opioid, sympathomimetic, anticholinergic, cholinergic, and sedative-hypnotic patterns, each defined by a constellation of signs and symptoms. For example, opioid toxidrome presents with respiratory depression, miosis, and decreased consciousness, whereas sympathomimetic toxicity shows agitation, tachycardia, and hypertension. Accurate early identification allows paramedics to prioritize therapies such as naloxone administration or preparing for airway management (Fuller et al., 2020).

5.3 Utilization of Point-of-Care and Field Diagnostic Tools

Paramedics increasingly employ point-of-care testing (POCT) devices to enhance onsite diagnostic capabilities, facilitating tailored treatment and triage. Common POCT tools include pulse oximetry to assess oxygen saturation, capnography for monitoring ventilation efficacy, and glucometers to exclude hypoglycemia, which can mimic or coexist with toxicologic emergencies (Moore et al., 2025).

Emerging portable toxicology and biosensor technologies offer promising avenues for real-time identification of specific toxins or drugs in the prehospital setting. These include handheld electrochemical sensors, microfluidic paper-based devices, and biosensors capable of detecting opioids, ethanol, or other common poisons rapidly. Although these technologies are advancing, challenges remain in sensitivity, specificity, ease of use, and cost-effectiveness before widespread adoption (Musile et al., 2023).

Integration of these diagnostic tools improves paramedic decision-making, allowing for better targeted treatments such as antidote administration and earlier activation of hospital toxicology resources. Continuous development and validation of field diagnostics are essential to optimize prehospital poisoning and overdose management (Oteo et al., 2023).

6. Prehospital Management and Interventions in Poisoning and Overdose

Paramedics play a critical role in the early management of poisoning and overdose cases, often setting the stage for patient outcomes through timely interventions in the field. This section covers key aspects: airway, breathing, and circulation support; specific antidotal therapies; intravenous access and monitoring; and decontamination and scene management.

6.1 Airway, Breathing, and Circulation Support

Airway protection is paramount in poisoned patients due to the risk of depressed consciousness and aspiration. Noninvasive airway management, such as bag-valve-mask (BVM) ventilation, is the first step and may suffice in many cases. However, indications for endotracheal intubation (ETI) include a Glasgow Coma Scale (GCS) less than 9, failure to protect the airway, refractory hypoxia, or inadequate ventilation despite BVM. The decision to intubate must consider potential complications such as hypotension, aspiration, and airway trauma. Pre-intubation optimization, including fluid resuscitation and cautious selection of sedation agents, reduces risks. Early oxygenation and ventilation significantly decrease morbidity and mortality related to respiratory compromise in poisoning (Freund et al., 2023).

6.2 Specific Antidotal Therapies

Paramedics are authorized to administer several critical antidotes in the prehospital setting. Naloxone remains the cornerstone treatment for opioid overdose, rapidly reversing respiratory depression and improving consciousness. Atropine is used in organophosphate poisoning to counteract cholinergic crisis, while hydroxocobalamin serves as an antidote for cyanide poisoning by binding cyanide ions. Activated charcoal administration, often within one hour of ingestion, adsorbs many toxins and can be started during ambulance transport to reduce delay to treatment. Limitations include patient tolerance, airway protection status, and the substances involved, as some poisonings do not benefit from charcoal. Field readiness requires paramedics to carry and be trained in antidote administration protocols (van Hoving et al., 2011).

6.3 Intravenous Access, Monitoring, and Communication

Establishing intravenous (IV) access allows for fluid resuscitation, antidote administration, and maintenance of circulation. Large-bore IVs are preferred to facilitate rapid fluid delivery if needed. Continuous cardiac monitoring is essential, as many toxins induce arrhythmias and conduction abnormalities; telemetry allows early detection and intervention. Paramedics must communicate key clinical information and early suspicion of poisoning to receiving hospitals and poison control centers to assist in expedited and targeted in-hospital care. Early notification improves readiness for specialized interventions upon patient arrival (Seymour et al., 2012).

6.4 Decontamination and Scene Management

Decontamination is vital to prevent ongoing absorption of toxins and secondary contamination of healthcare providers. Strategies differ by exposure route:

- **Dermal:** Removal of contaminated clothing, followed by thorough washing with water and mild soap; dry decontamination with brushing may be needed for solid agents (Johnston & Wills, 2023).
- **Ocular:** Immediate irrigation with saline or water for at least 15 minutes to minimize injury.
- **Inhalational:** Removal from the contaminated environment and administration of oxygen as necessary.

Paramedics must also coordinate scene containment to limit exposure to others and use personal protective equipment appropriately. Communication at the scene ensures safety and informs subsequent medical teams about decontamination status and residual risks.

7. Paramedic Protocols for Specific Poisoning Types

This section reviews current paramedic protocols for the early detection and treatment of various poisoning and overdose types. Paramedics play a critical role in recognizing symptoms, initiating life-saving interventions, and applying appropriate treatments in the prehospital setting. Each poisoning type has distinct clinical signs and management strategies, and paramedics must be skilled in tailoring their approach accordingly. Let's explore protocols for the following categories:

a. Opioid overdose (including fentanyl)

Paramedics assess patients with decreased mental status and respiratory depression, suspecting opioid involvement. Rapid administration of naloxone, an opioid antagonist, is the standard of care. Due to the potency of synthetic opioids like fentanyl, multiple naloxone doses may be required to reverse respiratory depression. Supportive measures including airway management, oxygenation, and rescue breathing are emphasized. Continuous monitoring following naloxone administration is vital to detect re-narcotization. Protocols advise against harmful interventions such as stimulation or injecting other substances (Chou et al., 2017).

b. Benzodiazepine overdose

Management focuses primarily on supportive care. Paramedics monitor airway, breathing, and circulation closely due to the risk of respiratory depression. Oxygen supplementation is provided when necessary. Because benzodiazepine overdose rarely leads to death by itself, aggressive interventions are reserved for respiratory compromise. Flumazenil, a benzodiazepine antagonist, is generally avoided due to seizure risk in chronic users (Kang et al., 2023).

c. Organophosphate poisoning

Exposure to organophosphate pesticides or nerve agents causes cholinergic symptoms like salivation, lacrimation, and muscle tremors. Paramedics initiate decontamination by removing contaminated clothing and rinsing patients. Immediate administration of atropine to reduce secretions is critical, repeated every 5 minutes until lung sounds clear. Concurrent use of pralidoxime helps reactivate acetylcholinesterase. Oxygen delivery and airway patency are supported aggressively (Eddleston et al., 2008).

d. Carbon monoxide poisoning

Paramedics must swiftly remove patients from exposure sites. High-flow 100% oxygen is administered to hasten carbon monoxide elimination. Airway management and advanced airway insertion are performed as needed. Continuous monitoring includes ECG and neurological assessments. Patients are transported to facilities capable of hyperbaric oxygen therapy when indicated (Weaver, 2014).

e. Alcohol intoxication and methanol poisoning

For alcohol intoxication, paramedics focus on airway protection due to potential respiratory depression. Monitoring vital signs and neurological status guides further interventions. Methanol poisoning requires rapid recognition due to risk of metabolic acidosis and vision loss. Protocols emphasize supportive care and antidotal therapy with agents like fomepizole and ethanol to inhibit methanol metabolism (Sarkar et al., 2023).

f. Snake and venomous bites

Paramedics assess the bite location, type of snake if known, and patient vitals. Immobilization of the affected limb below heart level is recommended. Avoidance of tourniquets or excessive pressure is important. Intravenous access is established for fluid resuscitation and potential antivenom administration. Continuous monitoring and transport to definitive care facilities are critical (Parker-Cote & Meggs, 2018).

8. Challenges in Prehospital Management

Paramedics play a critical role in the early detection and treatment of poisonings and overdoses; however, several significant challenges complicate effective prehospital management in these emergencies.

In the prehospital environment, paramedics typically have limited access to advanced diagnostic resources available in hospital settings. This scarcity of diagnostic tools complicates timely and accurate identification of the specific toxins or substances involved in poisoning or overdose cases. Paramedics often must rely on clinical assessment, patient history (which may be incomplete or unavailable), and physical signs to make rapid decisions without confirmatory laboratory tests. For instance, the differentiation between opioid overdose versus other causes of altered mental status may be critical but challenging without point-of-care toxicology screens. The absence of real-time diagnostics can delay targeted antidote administration and complicate supportive care strategies (Martínez-Sánchez et al., 2020).

Another considerable challenge is the frequent lack of complete information about the toxic exposure scene. Paramedics may encounter patients alone or in environments where witnesses are unavailable or unreliable, limiting knowledge about the type, amount, and timing of the poison ingested or inhaled. Scene safety assessments and gathering collateral history from bystanders or emergency contacts may be hindered by chaotic or unsafe environments. These information gaps hinder optimal risk assessment and early treatment decisions and can complicate downstream communication with hospital staff for ongoing management (Martínez-Sánchez et al., 2020).

Paramedics face occupational hazards related to exposure to toxins during emergency responses. They are at risk of contact with chemical, biological, or radiological agents at scenes involving poisonings, industrial accidents, or hazardous substance releases. Prolonged or repeated exposure to such agents may pose acute toxicity risks and long-term health effects such as respiratory complications or carcinogenic potential, especially when handling volatile or unknown substances without adequate protective equipment. Ensuring paramedic safety requires strict adherence to decontamination protocols, use of personal protective equipment (PPE) including gloves, masks, and eye protection, and continuous training on hazard identification and management (Gonczaryk et al., 2022).

Administering antidotes in the prehospital setting presents complex legal and ethical issues. Paramedics work under strict legal frameworks governing scope of practice, consent, and administration of medications. In poisoning emergencies, rapid administration of antidotes such as naloxone for opioid overdose is life-saving; however, paramedics must balance urgency with legal safeguards, including obtaining consent when possible or acting under implied consent in incapacitated patients. Moreover, administering antidotes without clear diagnosis carries risks of adverse effects and potential medicolegal liabilities. Ethical principles such as non-maleficence (do no harm) govern treatment decisions, and paramedics must navigate dilemmas involving patient autonomy, especially when patients refuse care but are not competent to make informed decisions. Legal statutes vary by jurisdiction and include regulations on controlled substances and emergency treatment protocols, requiring paramedics to maintain current knowledge and operate within established guidelines to mitigate liability risks (Ogilvie et al., 2023).

9. Innovations and Future Directions

9.1 Use of Artificial Intelligence and Wearable Biosensors for Early Intoxication Detection

The integration of artificial intelligence (AI) with wearable biosensor technology represents a transformative advancement in the early detection of intoxication and poisoning. Wearable biosensors are small, non-invasive devices capable of continuously monitoring physiological and biochemical parameters such as heart rate, respiratory rate, temperature, glucose levels, and even specific biomarkers related to toxic exposure. AI algorithms, particularly those leveraging machine learning and deep learning, process large quantities of biosensor data in real-time to detect subtle anomalies that may indicate early

toxicological events before overt clinical symptoms manifest. These systems enable paramedics to conduct proactive, continuous monitoring and provide timely interventions (Haykal, 2024).

The Internet of Medical Things (IoMT) infrastructure supports secure and rapid transmission of biosensor data to clinical and emergency services in the field, facilitating prompt decision support. Despite the promising benefits, challenges such as data privacy, model transparency, sensor accuracy, and device interoperability must be addressed to fully realize the potential of AI-powered biosensors in emergency medical services (EMS) (Zhang et al., 2023).

9.2 Advances in Portable Toxicology Testing Kits

Portable toxicology testing kits have seen remarkable technological improvements, enhancing the capabilities of paramedics to rapidly identify and treat poisoning and overdose in prehospital settings. Modern portable devices include breathalyzers with fuel cell technology for precise alcohol detection, oral fluid testing kits allowing non-invasive and rapid drug screening, rapid urine test cups with multi-substance detection and adulteration controls, as well as rapid hair follicle tests for assessing long-term substance use (Alonzo et al., 2022).

The deployment of advanced portable kits allows paramedics to obtain accurate toxicology results on-site within minutes, which guides targeted and timely treatment decisions such as administration of antidotes like naloxone, or protocols for environmental decontamination. These advances reduce delays associated with laboratory testing and improve patient outcomes during acute poisonings or overdoses (Alonzo et al., 2022).

9.3 Community Paramedicine Programs Addressing Substance Use Prevention and Harm Reduction

Community paramedicine programs have emerged as innovative models expanding the role of paramedics beyond emergency response to include proactive substance use prevention, harm reduction, and care coordination. These programs empower paramedics to deliver specialized services in patients' homes and community settings, focusing on education about substance use risks, medication-assisted treatments, psychosocial support, and linking individuals to addiction treatment and social services (Wanner & Burch, 2024).

A hallmark of these programs is the harm reduction approach that meets individuals "where they are," emphasizing non-judgmental support and preventing overdose recurrence rather than punitive measures. Community paramedics become trusted healthcare resources, reducing unnecessary emergency calls and hospital transports while improving access to care for vulnerable populations struggling with substance use disorders (Bolster et al., 2023).

9.4 Interdisciplinary Collaboration Linking EMS with Public Health and Mental Health Services

Interdisciplinary collaboration between EMS, public health entities, and mental health services is increasingly recognized as vital to effectively managing poisoning and overdose crises. EMS systems are developing structured partnerships with mental health professionals and public health agencies to facilitate holistic care models that go beyond acute stabilization and transport (Ding et al., 2023).

Examples include co-responder models where paramedics work alongside social workers or crisis counselors to assess, triage, and refer patients to appropriate care pathways such as mental health facilities or community-based treatment centers. These collaborative approaches reduce repeat emergency visits, improve patient-centered care, and leverage community resources to address the complex psychosocial determinants of substance use and overdose (Ding et al., 2023).

Public health integration also enables EMS data to be utilized for real-time overdose surveillance and monitoring trends, fostering timely public health interventions and resource allocation to high-risk communities (Ding et al., 2023).

Conclusion

Paramedics play a pivotal frontline role in the early recognition and management of poisoning and overdose, critically impacting patient survival and morbidity. Timely prehospital identification and intervention, including airway management, antidote administration, and decontamination, are essential components of effective EMS care. Despite advances, challenges such as limited diagnostic resources, inconsistent protocols, and legal-ethical complexities persist. Emerging innovations like AI-powered biosensors and portable toxicology testing kits hold promise for enhancing paramedic diagnostic accuracy and treatment precision. Furthermore, community paramedicine programs and interdisciplinary collaboration with public health and mental health services represent vital pathways for expanding the EMS role in harm reduction and substance use prevention. Addressing existing gaps through standardized training, enhanced toxicology integration, and improved communication systems is critical to optimizing paramedic contributions in poisoning and overdose emergencies. This review highlights the necessity for continued research and policy development to support evidence-based prehospital care frameworks that improve patient outcomes in this evolving and high-burden clinical area.

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